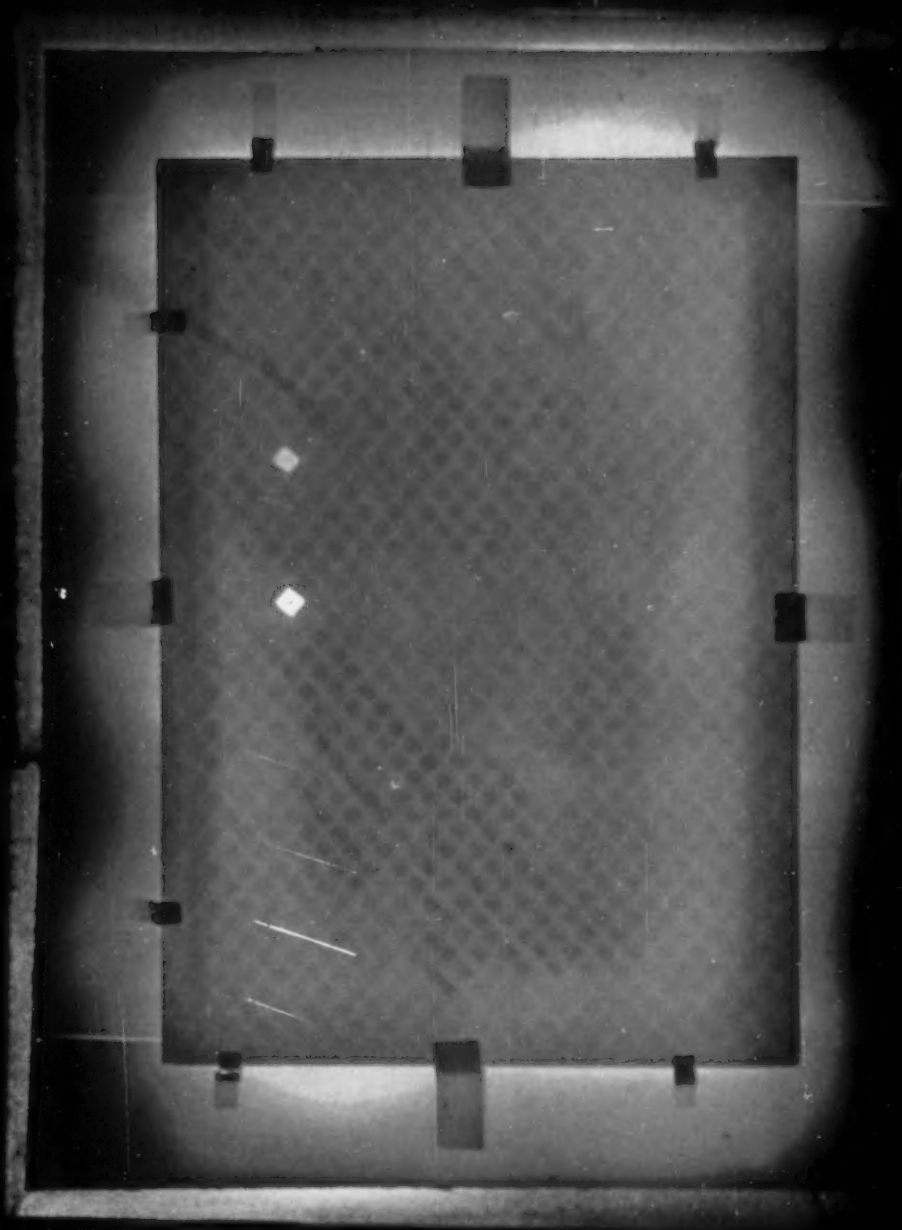
DECEMBER 8, 1958 Price 50 cents

Product Engineering

DESIGN issue

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT



MULTIPLE BRAZING

Heat inspects honeycomb→, see page 5

VALUE ANALYSIS where it really counts ... during design!

C/R Shaft Type Oil Seal

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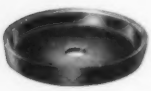
C/R Sirvene Diaphragm



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C/R Rawhide Beveled Gear

Here's an expert at work, saving you money at the right time — during design. Like all C/R sales engineers, he's an experienced, well-trained representative whose knowledge springs from a solid engineering background. His ability to sit down with you during the design phase will help develop the most efficient and economical solutions to your problems.

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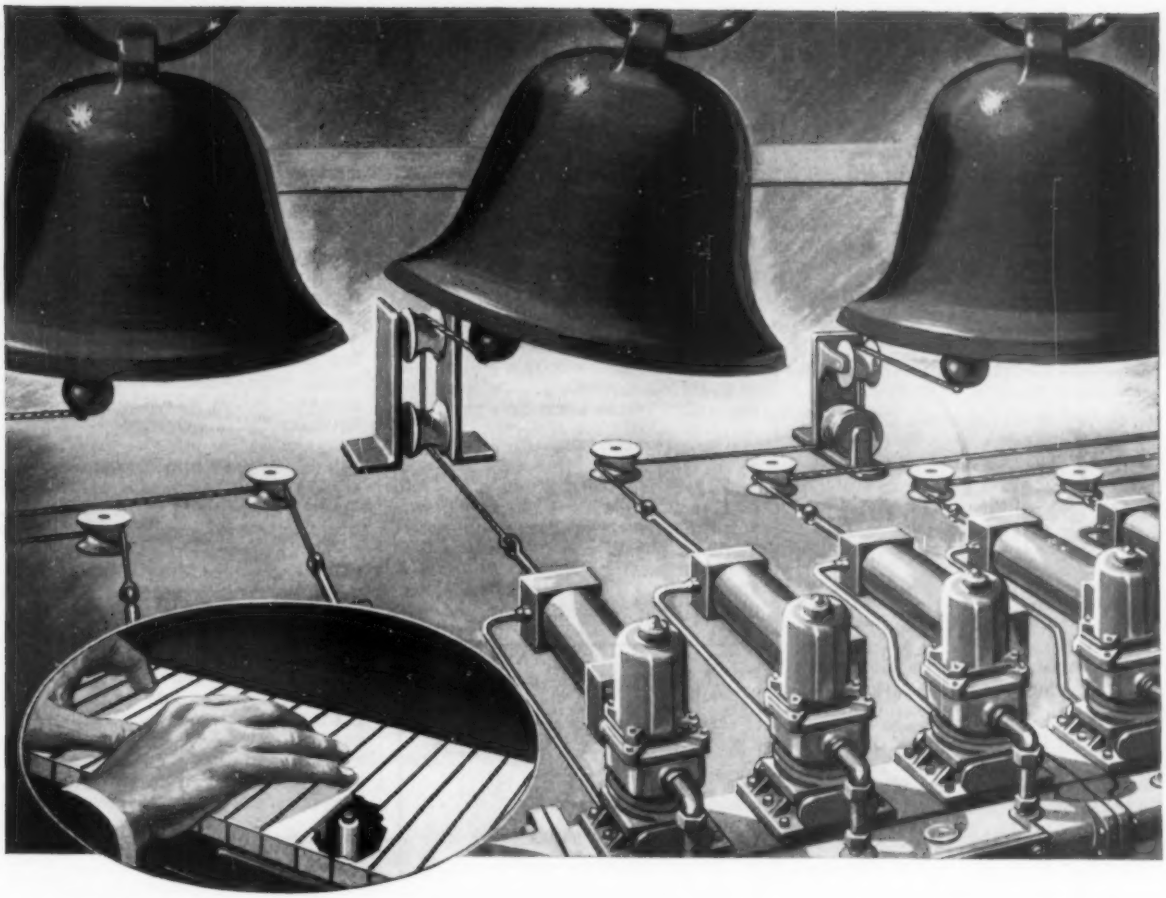


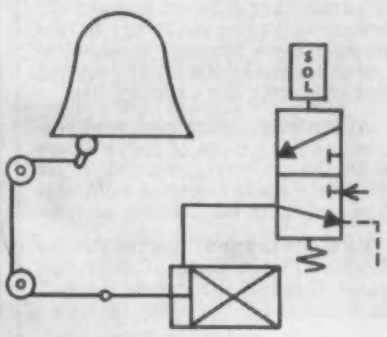
What? Air Power Rings the Bells!

Air powered clappers for the bell tower may be strictly fiction, but . . .

Can you imagine a keyboard that's a set of electrical switches. They operate a set of solenoid valves which in turn advance and retract cylinders. The cylinders, of course, pull the clapper cords. Shows that anything can happen when an air-minded engineer gets in the spirit of the season. But while this is just a flight of the imagination that you aren't likely to see installed in a carillon soon, you might very well want to take advantage of the underlying idea in some of your *plant operations*. Here is the idea:

Just one operator can control hundreds of operations by using solenoid valves.

And these solenoid valves, you'll notice, are manifolded. The manifolding saves piping, space, etc., just as has been possible for years with Ross valves that are operated manually, by air, cams, etc. Incidentally, you won't find this manifold in our catalog . . . it is one of the many refinements and variations of the standard Ross line that make it so flexible. To keep fully aware of the developments continually being made to increase the flexibility of the Ross line, keep in close touch with your local Ross Valve Engineer.



SEQUENCE OF OPERATION

Every time solenoid is energized, bell clapper is pulled against bell.

ROSS OPERATING VALVE CO. 114 East Golden Gate • Detroit 3, Michigan

Why metals corrode...and how you can prevent it

The equipment you design will most probably have to stand up against one or more of these 6 different forms of corrosive attack:

1. General tarnishing or rusting with occasional perforations in highly affected areas.

2. Highly localized attack by pitting.

3. Cracking induced by a combination of stress and corrosion.

4. Corrosion confined to crevices, under gaskets, or washers, or in sockets.

5. Corrosion of one of an alloy's constituents leaving a weak residue.

6. Corrosion near the junction of two different metals.

HOW CORROSION OCCURS

The basic cause of corrosion is the instability of metals in their refined state. Metals tend to revert to their natural states through the processes of corrosion. For example, when you analyze rust, you will find it is iron oxide. When you analyze natural iron ore, you find it, too, is iron oxide.

In all of the six forms of corrosion mentioned above, corrosion has the same basic mechanism. It's similar to the electrochemical action in a dry cell.

The electrolyte in the dry cell corresponds to the corrosive media, which may be anything from the moisture in the air to the strongest alkali or acid.

The plates of the battery correspond to the metal involved in corrosion.

A potential difference between these metals or different areas on the same metal causes electricity to flow between them through the electrolyte and a metallic bridge or contact that completes the circuit.

At the anode, a destructive alteration or eating away of metal occurs when the positively charged atoms of metal detach from the solid surface and enter the solution as ions.

The corresponding negative charges, in the form of electrons, travel through the metal, through the metallic bridge, to the cathode.

Briefly then, for corrosion to occur, there must first be a difference in potential between the metals or areas on the same piece of metal so that electricity will flow between them. Next, a release of electrons at the anode and a formation of metal ions through disintegration of metal at the anode. At the cathode, there must be a simultaneous acceptance of electrons. Action at the anode cannot go on alone, nor can action at the cathode.

CONTROLLING CORROSION

When corrosion occurs because of the differences in electrical potential of dissimilar metals, it is known as galvanic action. Differences in potential from point to point on a single metal surface causes corrosion known as local action.

When you plan against galvanic corrosion it is essential to know which metal in the couple will suffer accelerated corrosion . . . will act as the anode in the corrosion reaction.

The galvanic series table shown below can supply this information. In any couple, the metal near the top of this series will be the anode and suffer accelerated corrosion in a galvanic couple. The one nearer the bottom will be the cathode and remain free from attack or may corrode at a much slower rate.

GALVANIC SERIES TABLE

Magnesium
Magnesium alloys
•
Zinc
•
Aluminum 25
•
Cadmium
•
Aluminum 17ST
•
Steel or Iron, Cast Iron
•
Chromium-iron (active)
•
Ni-Resist
•
18-8 Stainless (active)
18-8-3 Stainless (active)
•
Lead-tin solders
Lead, Tin
•
Nickel (active)
Inconel (active)
•
Brasses, Copper, Bronzes
Copper-nickel alloys, Monel
•
Silver solder
•
Nickel (passive)
Inconel (passive)
•
Chromium-iron (passive)
18-8 Stainless (passive)
18-8-3 Stainless (passive)
•
Silver
•
Graphite, Gold, Platinum

HOW TO USE THE CHART

Notice how the metals are grouped in the galvanic series table. Any metal in one group can be safely used with any other metal in the same group. However, when you start mixing metals from different groups, you may run into serious galvanic corrosion of the metal higher on the list. And the further apart these metals are listed, the worse this corrosion may be.

But, if you have to mix metals, pay particular attention to the electrical contact between them. Eliminate any metallic bridges or contacts of metal to metal that will permit the flow of electrons through them. You can do this by separating the metals physically, or by using insulation or protective coatings. Another factor is the relative areas of the metals in contact with each other. Parts having the smaller area should be of a metal with a lower listing on the galvanic series table than the metal used for the larger area.

When you plan against local action, keep in mind that the corrosion process is similar to galvanic action . . . a movement of electrons from one point on the metal to another. Naturally, the easiest way to avoid local action is to use a metal with little or no impurity . . . or an alloy with constituents that are listed closely on the galvanic series table . . . like Monel* nickel-copper alloy or Inconel* nickel-chromium-iron alloy. Local action on other metals, however, can be controlled by stopping any flow of electrons . . . such as with protective coatings. Environment, too, is a factor for consideration.

TECHNICAL ASSISTANCE

As you can see, many factors are involved in both local and galvanic action. That's why it's best to bring your metal problem to Inco's Corrosion Engineering Service. Available data will be furnished wherever possible . . . tests will be made where needed. Inco's Corrosion Engineering Service will be glad to apply principles of corrosion control to your specific problem.

LITERATURE

The publications listed below will provide more detailed information on how you can combat corrosion by using Inco Nickel Alloys.

T-13.... Nickel and Nickel-Base Alloys
T-3..... Monel in Sulfuric Acid
T-6..... The Resistance of Nickel and Its Alloys to Corrosion by Caustic Alkalies
T-29.... Resistance of Nickel, Monel and Other High-Nickel Alloys to Corrosion by Hydrochloric Acid, Hydrogen Chloride and Chlorine
8-141... Handling Fluorine and Fluorine Compounds with Inco Nickel Alloys

A complete list of the more than 100 Inco publications and technical bulletins on Inco Nickel Alloys can be obtained by writing for "List B", to:

*Registered trademark

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street (INCO) New York 5, N. Y.

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

DECEMBER 8, 1958 Vol. 29, No. 50

One Temperature—Successive Brazes 84... G D Cremer and R S Mueller, Solar Aircraft Co
How tighter production control with special brazes allows multiple brazing—without reducing operating temperature of final assembly. Method can hold rejects down to 2%.

*

Superior Linkage Joints 87... Ho Chow, Westchester Technical Corp
In the many ingenious methods made possible by linkage design, controlling factor is the joint—its form, attachment, specification. Article discusses these variables in terms of approach to an ideal linkage joint.

Design Features in New Products 92... Tape recorder has many speeds but no reel; stacking the components simplifies assembly; cams drive steel-squeezing dies.

New Concept in Air Lubrication 96... C R Adams, Boeing Airplane Co
It's the step bearing, described here by the man who developed it. Rugged and inexpensive, it can be operated with air, gas, water or mercury—at high or low temperatures and speeds.

*

Designing with Swivel Joints 100... G M Bagnard, Chiksan Co
A workable arrangement can become a difficult puzzle, especially when pipe connections involve three dimensions. Here's a basic approach that will eliminate wrong guesses.

Choosing Selector-switch Knobs 103... G A Peters, Psychological Research Associates Inc
A quick look at a better way to design panel controls.

Hottest Thing in Plating 104... R D Stackhouse, A E Guidotti, D M Yenni, Linde Co
With its working temperatures of over 20,000 F, the plasma-arc torch can melt, then deposit, balky metals like tungsten. Here's first production data on coating properties and design parameters.

DESIGN FILE

More Work for the Busy Staple 108... H G Allen, Bostitch Inc
A roundup of the types, and the ways they are clinched.

Pressure Cylinders 111... E J Cattabiani, Westinghouse Electric Corp
Curves cut calculations for stress in the flat-ended type.

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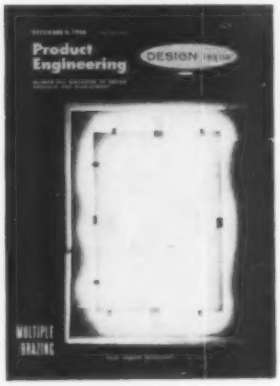
Interesting to Note . . .

It Began with Bees



Credit for scientific developments has often gone to members of the animal kingdom. It's been said that radar grew out of the curiosity of an inventor–he was wondering why bats don't bump into the walls of dark caves and buildings. Watching birds in flight tempted scores of would-be birdmen into constructing machines most of which were supposed to fly by flapping their wings–even the great DaVinci sketched such a flapper that never got off the drawing boards. Now add another inspirational creature. Eons ago the first honeybee built the first honeycomb and design engineers have borrowed that idea very successfully for honeycomb construction.

Our cover shows a honeycomb of square cells (the bee's are hexagonal) being inspected by radiant heat technique at Solar Aircraft Co, San Diego. When the panel is placed against the opening of a furnace at 1750 F, heat is conducted quickly through the honeycomb material, more slowly through the air spaces. Good bonds between honeycomb and outer face conduct heat efficiently, thus outlining a high-temperature radiant pattern on the outer sheet. Lack of bond shows as a break in this pattern. Intensity of thermal gradient is demonstrated by two bright spots: brightest shows effect of both facings removed at one spot, duller shows effect of removing a piece of outer facing only. Thermal gradient technique can also be employed with frost or heat-sensitive paint on the outer surface, but heat control is more critical. Other aspects of high-temperature precision brazing are covered in the article on p 84.

Honeycomb as a structural material evolved from a bee's comb–just how is not fully known. However, during World War II, the British incorporated balsawood sandwich elements in their low-level attack bomber, the Mosquito. The Martin Co soon pioneered honeycomb in this country, using it in the Matador ground-to-air missile. Honeycomb made possible a pair of wings with less than 500 parts, while a stabilizer of conventional design and comparable size has 3000 or more.

Come to the Fair

Every so often we take time to evaluate our accomplishments. Industry does this by renting a hall and parading the newest line before all those interested. When this is done internationally we have a World's Fair, the latest of which just closed at Brussels.

(Continued on page 7)

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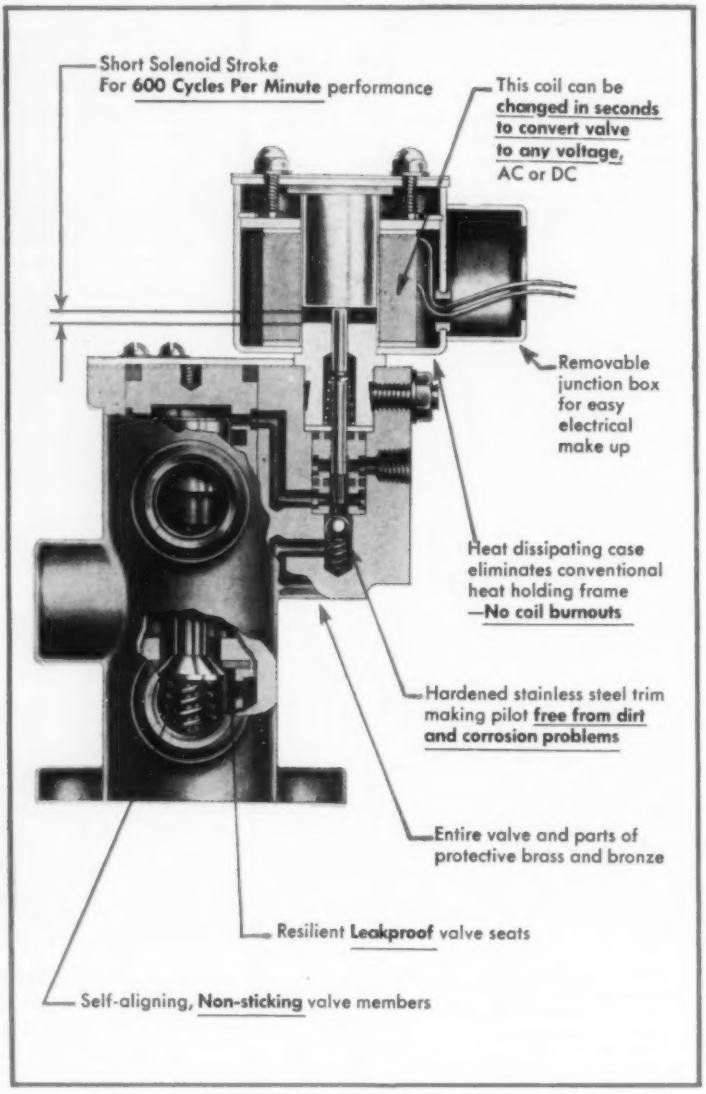
CONTINUALLY LEAKPROOF & DEPENDABLE
even in dirty outdoor applications like this. The Crescent® valve has been standard equipment on cement batching plants manufactured by the Noble Co. Thousands of Crescents® have stood up in this contaminated service.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For 600 Cycles Per Minute performance
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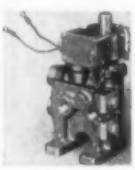

J.I.C. Type 4-Way

Type 'MK' Auxiliary Manual Control

Type 'L'

barksdale valves CONTROL VALVE DIVISION

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Standard 3-Way

Explosion-Proof 3-Way

Interesting to Note . . . . *(continued)*

What was perhaps the greatest World's Fair occurred in Philadelphia 82 years ago in celebration of the Republic's 100th birthday.

The Centennial of 1876 sprawled over about 70 acres of floor space, most of it in five big halls. Better than 8 million people paid over $4 million to witness the mechanical spectacles on display. Richard Wagner wrote the Centennial Inauguration March to open the fair, which was followed by a thousand-voice choir singing a hymn by Whittier. It had been hoped the Statue of Liberty would be completed for unveiling at the same time but the French sculptors had completed only the famous upraised hand. This was sent to Philadelphia and put on display.

Of the five Fair buildings, the most impressive was the Main Hall, called the largest building in the world. Next to it was a huge railroad station specially built by the Pennsylvania Railroad to accommodate the millions of spectators. Crowds came in such numbers the railroad let people ride to the fair in fruit cars. Across a vast mall from the Main Hall was Machinery Hall. Here President Grant and Brazil's Emperor, Don Pedro, officially opened the fair by starting a steam engine. Because the fair's main theme was power, the loud noise of the giant Corliss engine was most impressive. It was the greatest steam engine ever built, generating 1600 hp to supply power that ran all machines in the hall. When George Pullman saw the engine in operation he purchased it for his railroad-car factory. Also on public display for the first time was the Hoe printing machine which printed 25,000 sheets an hour; the first true bandsaw showed how a power tool could cut the most intricate pattern from wood; Germany sent guns from its Krupp Works; England, a steam hammer.

Steam power set man's imagination in motion. New tools could work metal and wood with greater speed and accuracy than ever before. Previous metal-shaping machines had consisted of hammer, chisel and file. Lathes were crude and difficult to use. Drills had to be operated by hand to provide any precision at all. Such machines for forming materials as the metal-squeezing press described on page 92 got their inception with the harnessing of steam. The Centennial not only served as a display for past progress but provided an inspiration for future inventors like Edison and Bell. Robert Millikan, discoverer of the electron, remembered the fair as a fairyland and after seeing the wonders of science decided to be an engineer. Our bicentennial as a nation is just 18 years away. For what feats of science will our generation be remembered?

How Hot is Hot?

When the Greek philosophers said all matter is composed of four elements—earth, water, air, fire—maybe they weren't so wrong, after all. If small adjustments in definition are made, one can speak of the four stages of matter as solid, liquid, gaseous and the high-temperature state. Temperatures in the 5-10,000 F range have been reached by electric furnaces and, more recently, by solar furnaces, but that's not hot enough. Never before in the history of scientific development has it been so necessary to utilize heat beyond that obtainable in a chemical change. As we gain more and more information about the behavior of atoms, we find the need to reach previously "impossible" temperatures has become imperative.

Pyrogenics, research in the uncharted area of high temperatures, has unveiled new metallurgical techniques, further data on the makeup of materials, and even deeper insight into astrological happenings. Another outcrop from the pyrogenic R & D labs is a method of shaping metals like tungsten and molybdenum by a plasma-arc process. The article on page 104 discusses this new development.

Hook Tool

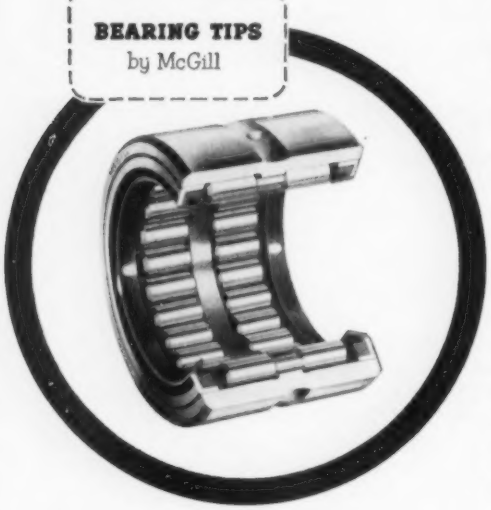
Smithsonian Institution

Flat-end cylinders like those described on page 111 require close tolerances and precision machinery. We have the tools and personnel necessary today, but machining in America 100 years ago was anything but precise. To turn a piece of metal required a "hook tool." Its 2-ft-long extended round wooden handle was tucked under the machinist's arm, then tooth-like serrations gripped the tool-rest on the lathe while a blunt-nosed tool did the cutting. It required courage and considerable brawn to hold the cutting edge of the tool against the rapidly spinning workpiece in the lathe, because the tool could easily become snagged in the workpiece, with painful results to the machinist. Because the tool could not be accurately controlled, tolerances could not be maintained.

Using this method meant each piece was personally built. Standardization was virtually unknown and interchangeable parts like those used in Eli Whitney's muskets back in 1800 were still only an unnecessary convenience. Actually, this seemingly crude method of cutting iron was one of the most important developments of the 19th century. The "hook tool" was short-lived however, for Henry Maudslay, an English machine designer, had developed a moving metal carriage in which a cutting tool could be held firmly. This seemingly simple device gave England undisputable superiority in the machine-tool field.

—Benedict A. Leerburger Jr

BEARING TIPS
by McGill



McGILL sealed GUIDEROL® bearings preserve high capacity performance of needle bearing applications

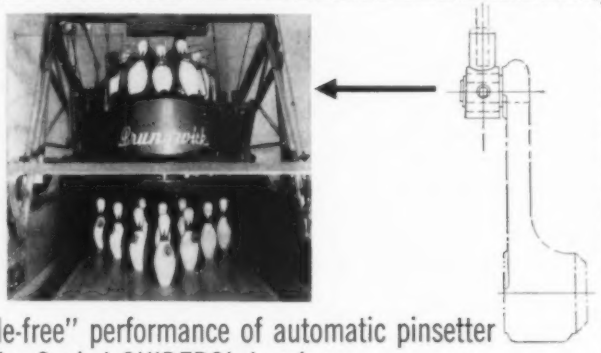
Lip type contact seals built into GUIDEROL bearings insure longer life for their high capacity performance in limited radial space. It's simpler and less costly to apply these sealed bearings than build in auxiliary seals that increase bearing width and housing requirements.

GUIDEROL bearings, including the sealed series, are precision built and combine the inherent high capacity of full complement roller bearings with the control of center guided rollers. This recommends the bearing for applications too heavily loaded for retainer type bearings, but where shaft deflection and misalignment prevents the use of ordinary full type roller bearings.

Seals keep contamination out and lubrication in. This assures trouble free performance where maintenance is costly or impractical.

Sealed GUIDEROL minimizes torque in ACF "Piggy-Back" trailer hitch

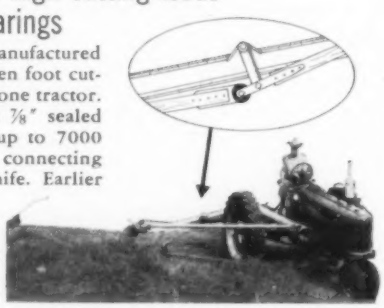
McGILL Sealed GUIDEROL bearings meet the requirements of a high capacity needle bearing for small radial space, having adequate seals to prevent entry of foreign materials and loss of lubricant in this exposed application. The bearings, in the elevating arms, minimize the amount of torque required to elevate the trailer hitch and jack the trailer off the car floor. The hitch, manufactured by American Car and Foundry Division of ACF Industries Incorporated, is a tiedown and cushioning unit for semi-truck trailers on flat car (Piggy-back) use. Although speeds are low, loads are as high as 20,000 lbs. per bearing. Grease relubrication when desired is applied through the shaft to the inner race of the bearing.



"Trouble-free" performance of automatic pinsetter called for Sealed GUIDEROL bearings

Prelubricated and Sealed GUIDEROL bearings are used in two applications in BRUNSWICK AUTOMATIC PINSETTERS; on the Rake Crank Lever Assembly and on the Jogger Arm Assembly. The photo shows the location of the sealed GUIDEROL Rake Crank Lever application in the "mechanical brain" of the machine. The sealed GUIDEROL bearings help keep the "brain" highly efficient, with a minimum of maintenance. In the Rake Crank they are not relubricated and operate indefinitely on retained lubricant. Effective seals keep out dirt and foreign matter.

New mower design takes high cutting loads on Sealed GUIDEROL bearings



These unusual field mowers manufactured by Kosch Mfg. Co. use two seven foot cutting bars for a 14 foot cut with one tractor. The second bar depends on a ⅞" sealed GUIDEROL bearing to carry up to 7000 pound loads produced in the connecting drive for the reciprocating knife. Earlier sleeve and lower quality needle bearings were discarded for sealed GUIDEROL bearings that have prevented costly field breakdowns.

engineered electrical products

McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

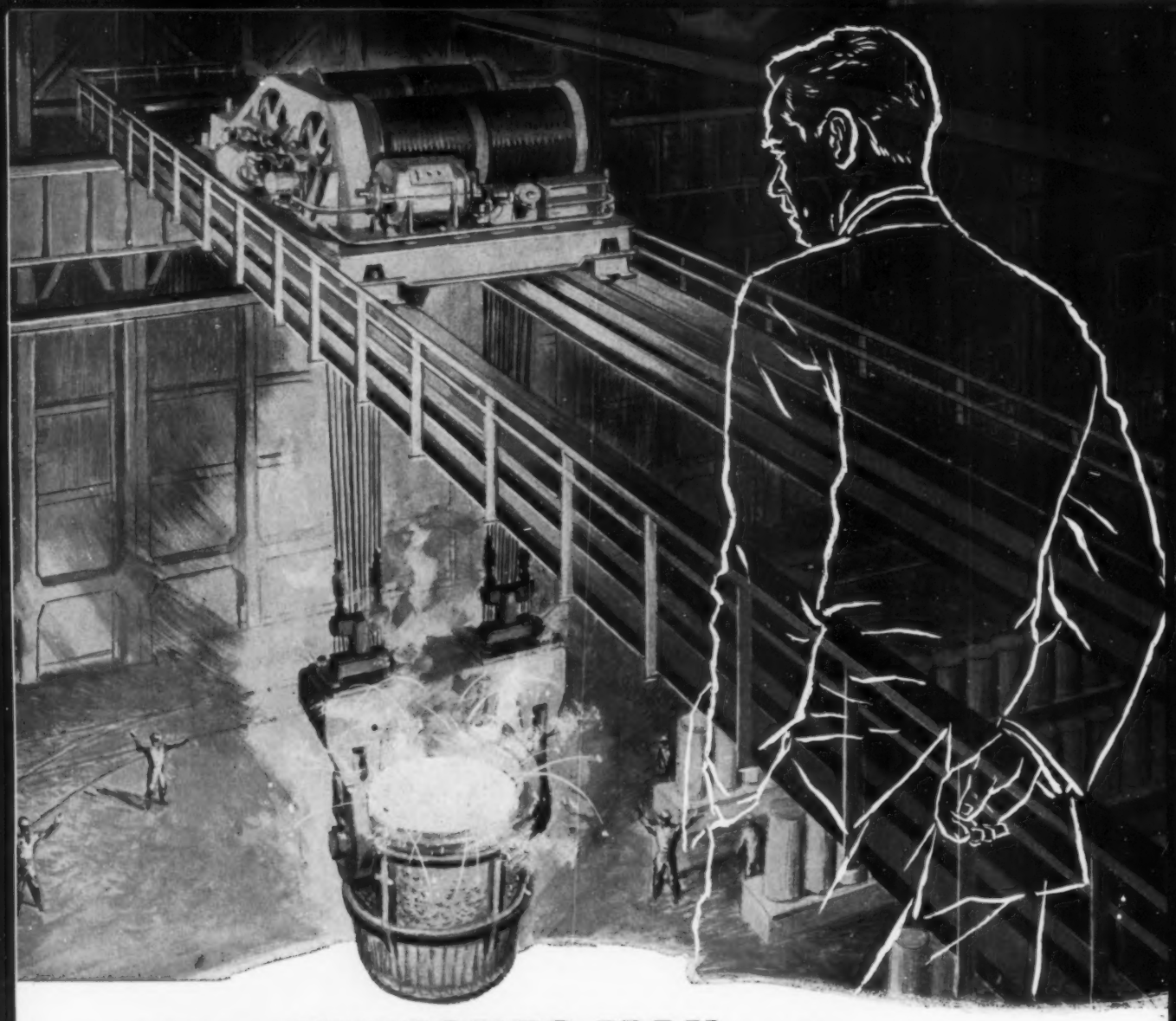
ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!



HOW THE SILICONES MAN HELPED...
ADD MUSCLE TO THE BRAWN THAT LIFTS A BUCKET OF STEEL

THREE HUNDRED tons of molten steel handled like a cup of tea. That's power with something to spare. But increases in production, the demand to do more work with small, compact equipment keeps electric motor design engineers on their toes.

The Elliott Company of Jeannette, Pa. is one of the leading suppliers of electric motors for steel mill applications. Recently, Elliott engineers wanted to increase overload capacity, life span, and resistance to corrosive atmospheres. They decided to use Class H insulation, and asked the Silicones Man to supply the necessary silicones. The result? A complete line of Class H mill motors with an expected life *ten times* that of present types! It's just one more example of how the specialized knowledge of the Silicones Man has helped solve an "impossible" problem.

Find out the latest information on silicones for Class H insulation or any of the other silicone products that solve problems of heat, cold, strength, corrosion. Call your Silicones Man, or address Dept. LP-6706, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. (*In Canada:* Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario.)

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

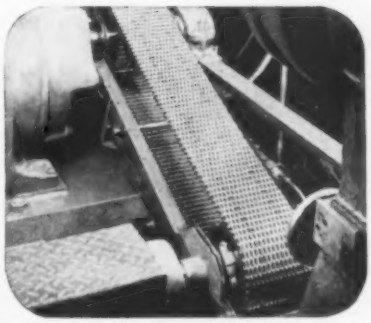
The term "Union Carbide" is a registered trade-mark of UCC.

UNION CARBIDE TRADE-MARK SILICONES

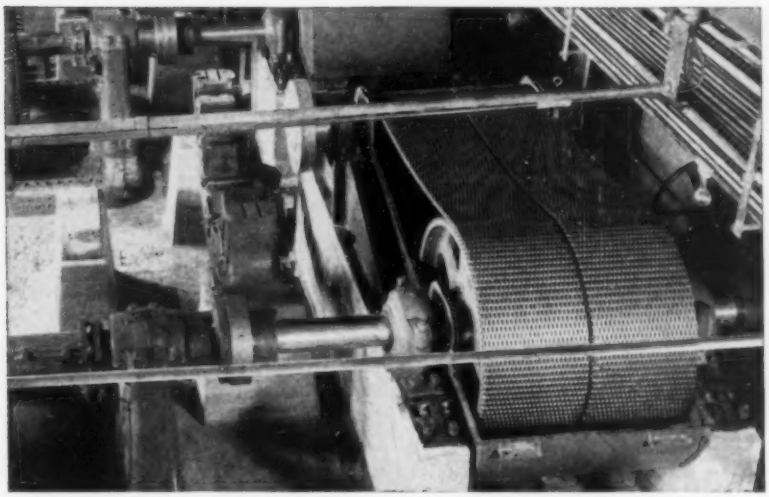
CIRCLE 106 READER SERVICE CARD

How LINK-BELT silent chain comes through industry's stiffest tests

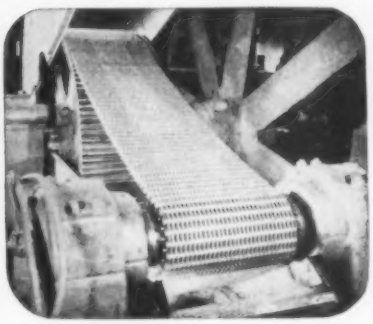
No other drive can do the same



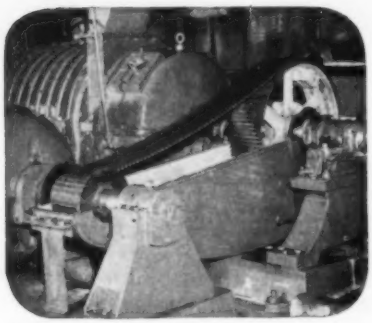
HIGH SPEED. Link-Belt silent chain drives on newspaper presses often operate at speeds of 4000 to 5000 feet per minute.



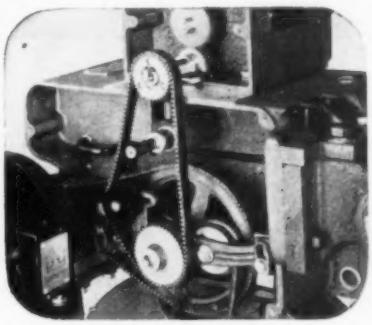
LARGE OR SMALL HP. Two 24-in. strands of Link-Belt silent chain on turbines powering 850-kw generators comprise one of the largest chain drives ever built. Silent chain provides high efficiency (over 98%) on large or fractional hp drives.



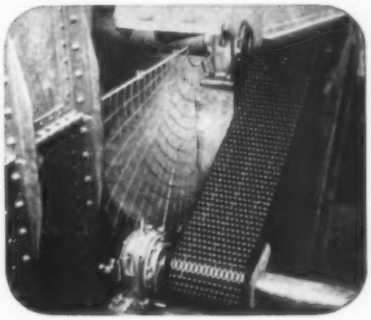
ADVERSE OPERATING CONDITIONS. Effects of heat, humidity and cold are minimized with Link-Belt silent chain drives.



LARGE RATIOS. Link-Belt silent chain operates efficiently at ratios as high as 10-to-1, with resulting space economies.



LIMITED SPACE. A complete drive as small as your thumb—Link-Belt 3/16-in. silent chain is ideal for limited-space applications.



LONG LIFE. Link-Belt silent chain has given more than 30 years of uninterrupted service on ventilating systems.

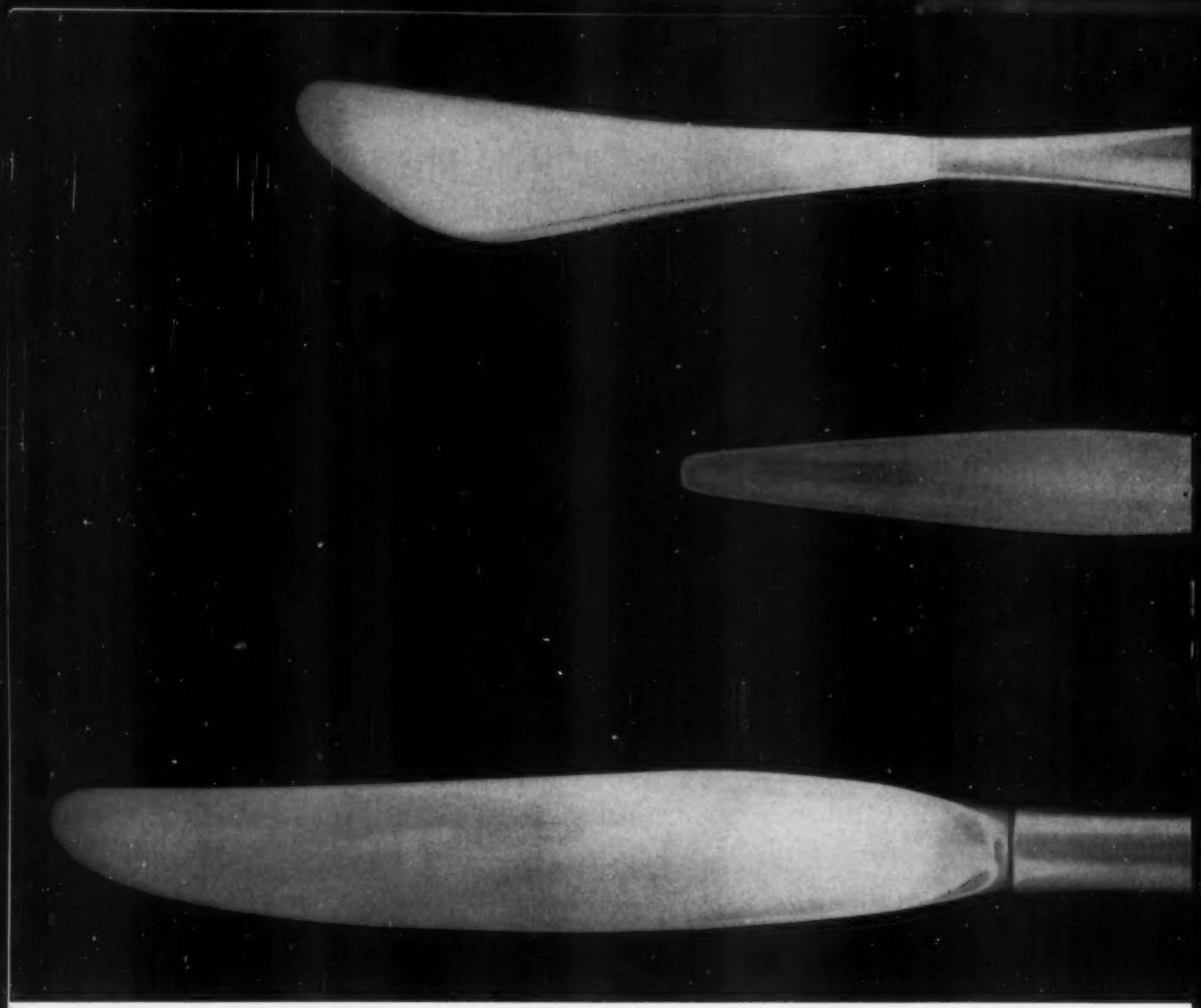
Get in touch with your nearest Link-Belt office for

88-page Data Book No. 2425

LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,680-A



Good Design—Let's say that you were asked to design a *fish*. It's to be the most ferocious monster of the deep, a murderous creature ideally adapted to the sea. Chances are you would end up with something much like a 40-foot-long Great White Shark.

Then assume that you were asked to design the most efficient possible device to span a large body of water. You would very likely end up with something like the familiar high-towered suspension bridge.

You could then take these designs to any great artist and he would say, "They are beautiful"—even if he didn't know how or why you had designed them.

Why are they beautiful? Probably because they are so absolutely functional. In the astringent design of a fish or a bridge, lines are curved only when they should be curved—to add strength or streamlining. *Materials* are used functionally, too. You don't make a shark's tooth from cartilage. You don't make a suspension bridge from anything but steel.

As we develop more and more "styled" products, the choice of material becomes very important. For example, the flatware industry has been revolutionized by Stainless Steel because of its unbeatable combination of luster, strength, corrosion resistance and formability. The landscape gleams with steel curtain wall buildings as we learn to use steel in bold, bright, colorful ways. Even huge power shovels take on a new beauty as ultra-strong steels slim their silhouettes.

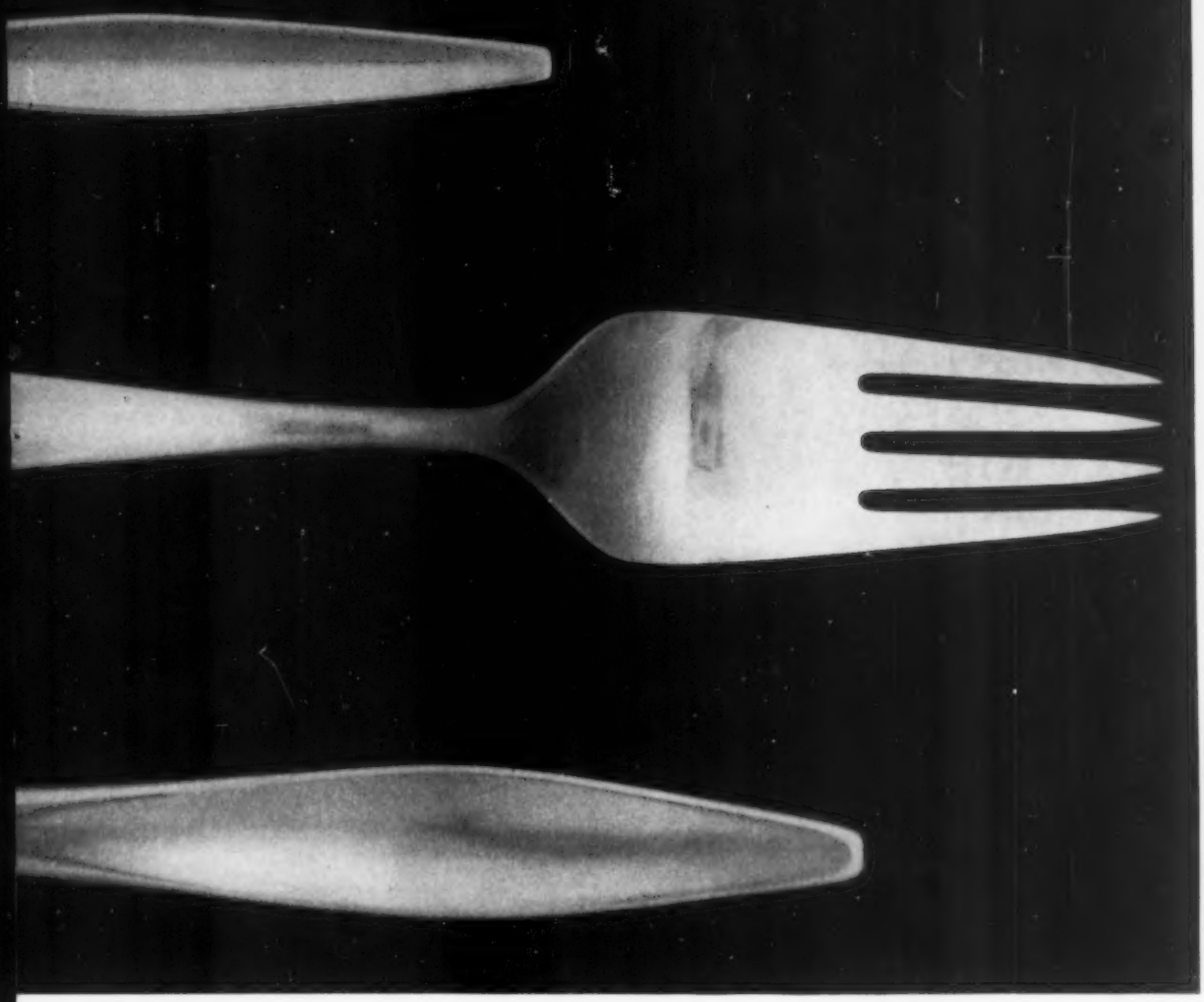
It's the same story with thousands of other products. And for any application, there is one steel best suited for the job—one that contains physical properties, appearance and price in the right package. It can be selected from the large family of USS Design Steels: Carbon, High Strength, Alloy and Stainless.

Any time you want help in making that selection, call United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

STEELS FOR DESIGN

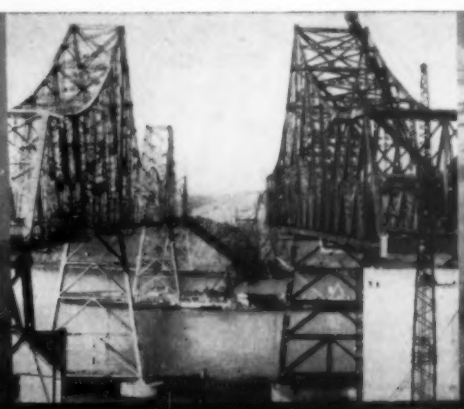


Lower Left: Problem: Combine ruggedness, safety, and beauty in a pleasure yacht. Solution: Designer used USS COR-TEN High-Strength Low-Alloy Steel. Pay-off: Hull is stronger and more resistant to corrosion. Welded construction allowed separation of the gasoline and bilge areas, helps eliminate the most common boat disaster—fire. Formability of COR-TEN made it easy to shape the sleek, curving hull.

Lower Middle: Match profile of a new cantilever bridge (right) with existing bridge, but build it stronger to support wider roadbed. Solution: USS "T-1" Constructional Alloy Steel (now available at 100,000 psi min. yield strength) and USS TRI-TEN High-Strength Low-Alloy Steel. Pay-off: "T-1" Steel alone saved $800,000 by slimming down massive members. All shop connections are welded. "T-1" 's weldability enabled clean, graceful members contrasted to laced and riveted members in old bridge.

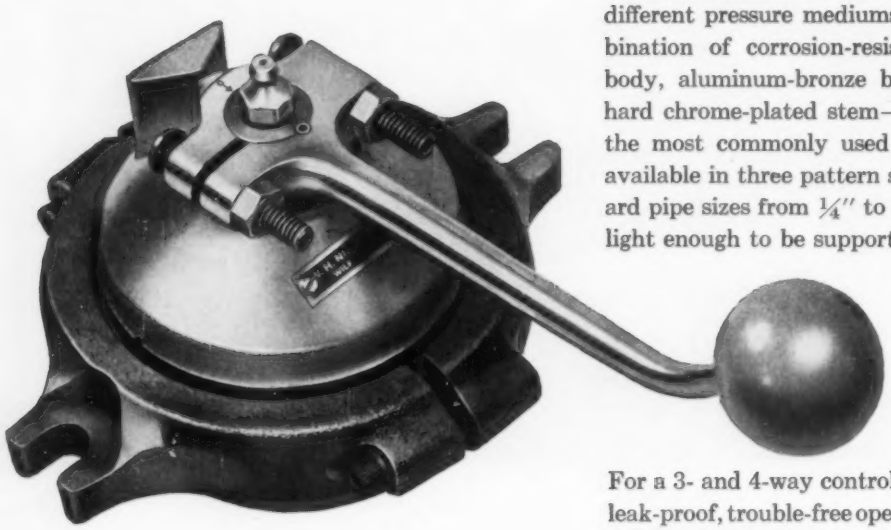
Lower Right: Problem: Portray 20th century Pittsburgh in a metal mural for a Pittsburgh hotel. Solution: Artist selected Stainless Steel for most of the job. Pay-off: A mural that is permanently beautiful. Says sculptor Rene Shapshak, "This is the Stainless Steel Age."

USS, "T-1", Cor-Ten and Tri-Ten are registered trademarks



Here's a control valve that assures you

leak-proof service



Highly-lapped metal-to-metal surfaces of this Nicholson control valve assure you leak-proof service. The O-ring stem packing and O-ring seal between the body and base make joints leak-proof without excessive bolt tension.

You can use the Model 300 with air, water, hydraulic fluid or oil as the pressure medium . . . at operating pressures to 300 psi. Use it to activate single- or double-acting cylinders. Simple and rugged, this valve provides accurate, repeatable control of equipment such as presses, hoists, clutches and chucks. Valve maintenance is no problem . . . all stem, base and disc bearing surfaces are lubricated through one easily accessible fitting on top of valve stem. Lubricant reservoir in base reduces frequency of lubrication.

No need to stock valves or parts for service with different pressure mediums. This valve's *one* combination of corrosion-resistant materials—bronze body, aluminum-bronze base, stainless-steel disc, hard chrome-plated stem—is well suited for all of the most commonly used pressure mediums. It's available in three pattern sizes covering five standard pipe sizes from ¼" to 1" . . . small enough and light enough to be supported by connected piping.

For a 3- and 4-way control valve that will give you leak-proof, trouble-free operation, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. Sales and Engineering Offices in 98 principal cities.

Write for Bulletin 300 . . . covering design, construction, sizes and applications for the Model 300

NICHOLSON

OF WILKES-BARRE

RELIABILITY WITH OHMITE® RELAYS

65 Types in four stock models mean industrial sales for you. Models DOS, DOSY, DO, and CRU are available. Models DO and DOS fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. The increased operating sensitivity of Model DOSY relay, equipped with twin coils, makes it adaptable to a wide range of electronic control circuits, such as plate circuit controls. Model CRU is outstanding for its wide range of available contact combinations, its small size, and rugged constitution. At 115 vac or 32 vdc, noninductive load, Models DOS and DOSY have contact ratings of 15 amp; Model DO, 10 amp; and Model CRU, 5 amp. Available in a wide range of coil operating voltages and contact combinations.

Write on company letterhead for Catalog 58.

TWO NEW OHMITE RELAYS

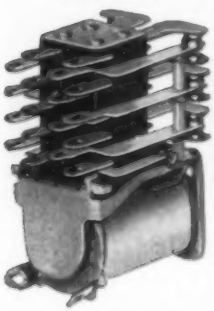
- with exclusive "Molded Module"* contact springs
- exceptional sensitivity for small size
- designed to meet aircraft, military, and industrial applications

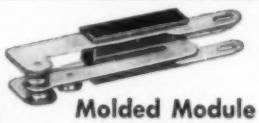
*patent applied for

The new Models TT and TS relays are lightweight, yet rugged. Paramount among the design innovations is the revolutionary "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw, spring combination molded into a single compact assembly. As many as six modules can be incorporated into a relay to provide a maximum six-pole, double-throw combination. With the springs rigidly held in a matrix of tough plastic, alignment of the springs is assured. More accurate alignment of all the subcombinations (modules) on the relay is possible, and adjustment of the individual contact springs is easier and more permanent. Diall Phthallate, the molding material, is capable of withstanding temperatures to 400°F.

A contributing factor to the remarkable sensitivity of these relays is the design of the armature retaining guard to minimize undesirable heel gap. A wide variety of hermetically sealed enclosures is available.

Model TT

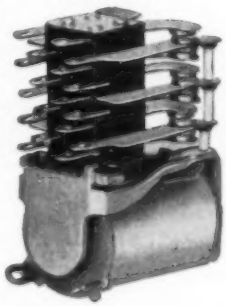




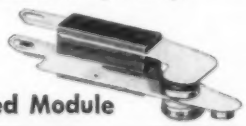
Molded Module

Coil Wattage: rated nominally at .150 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 5 amperes at 115 volts ac or 32 volts dc noninductive, with standard contact material, palladium. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 2 ounces for 4 pdt relay.

Model TS



Coil Wattage: rated nominally at .250 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 10 amperes at 115 volts ac or 32 volts dc noninductive with standard contact material, silver-cadmium oxide. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 3 ounces for 4pdt relay.



Molded Module

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

Be Right with OHMITE® QUALITY Components

OHMITE MANUFACTURING CO.
3611 Howard Street, Skokie, Illinois

Bushings and Washers *with bearing properties* Give Performance with Economy!

Formed bushings—alloy lined to provide some of the load-carrying characteristics of a bearing—are economical to produce. Oil grooves, holes, pockets, cut-outs, chamfers, straight, lock or special seams can be made in the flat blanks before forming. Available in solid bronze, or steel with babbitt, bronze or aluminum alloy linings, in a wide range of lengths and diameters.

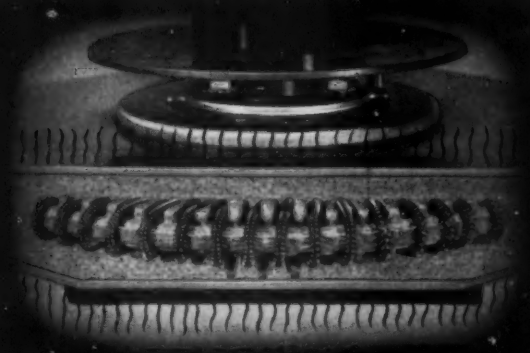
Precision thrust washers of solid bronze, or steel with bronze on one or both faces, may be flat, spherical or special shapes, with grooves, holes, nibs, lugs or scallops. Cold-rolled for exceptional hardness in heavy-duty use. 1″ to 6″ O.D.

Design data sent on request. Complete engineering service. Address:

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

FEDERAL Mogul SINCE 1899



Heat dissipation front and back

Adjustable stops

Wear-resistant contacts

Stable operation, hour after hour

FOUR REASONS WHY

G-E rheostats give top performance at low cost

General Electric plate rheostats offer many outstanding features to give you the best possible performance with minimum cost and maintenance. These features include:

Greater heat dissipation—completely metal-encased and cement-filled rheostat dissipates heat from both sides. This allows a smaller, lower-cost rheostat to be used for a given rating.

Easily adjustable stops—two movable stops can be set to predetermine the range of operation of the G-E rheostat.

Less contact wear—the movable contact rides on special wear-resistant segments, not on the resistance wire. This substantially increases the operating life of the rheostat.

Stable operation—once the rheostat is set on the desired rating, it will maintain that setting with negligible change in resistance, resulting in dependable "set-and-forget" operation.

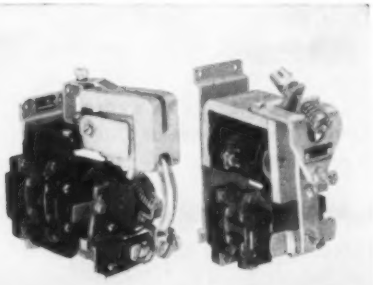
Act now! You can get G-E rheostats in six-, nine- or twelve-inch sizes, dissipating as high as 1100 watts per plate.

NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays and resistors for all your control needs. For more information, contact your G-E Sales Engineer or mail this coupon today! Industry Control Dept., Roanoke, Va.

GENERAL ELECTRIC

D-c contactors and relays—feature new "building-block" construction to give maximum flexibility with minimum inventory.



Vitreous-enameled resistors—1070 ohmic values from stock, fixed or slide wire, 5 to 200 watts. Call your G-E representative.

To: Section D784-14
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6474—Plate-type rheostats
- ☐ GEA-6592—Vitreous-enameled resistors
- ☐ GEA-6621—D-c contactors and relays

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Company _____

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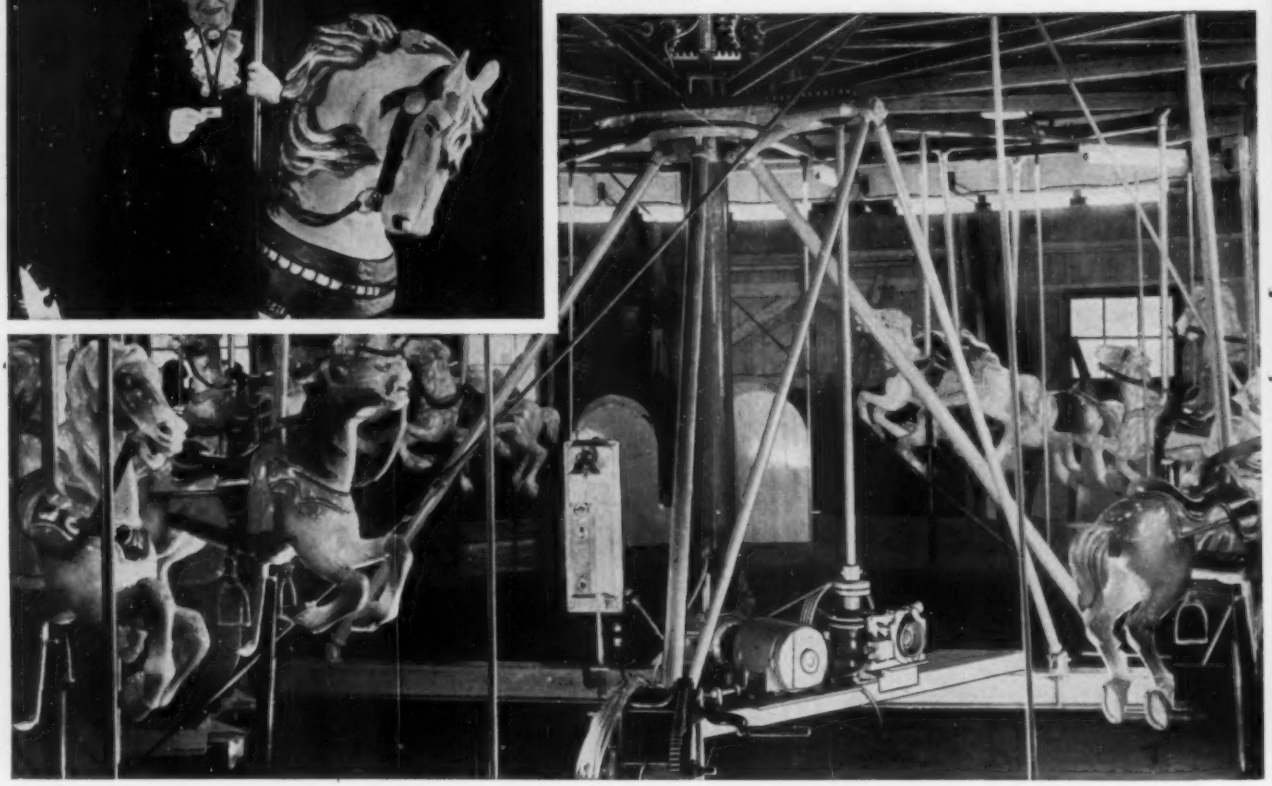
City _____ State _____

Since 1880, Allan Herschell Company, Inc., North Tonawanda, New York, have created safe, appealing rides in the highly specialized field of engineering and constructing carnival and park amusements. Republic ELECTRUNITE is used extensively.



Meet severe design, engineering, service requirements with

Republic ELECTRUNITE Mechanical Tubing

ROUNDS... SQUARES... RECTANGLES

Republic ELECTRUNITE® Mechanical Tubing offers many outstanding fabricating advantages in the highly specialized field of creating, engineering, and constructing carnival and park amusements. That is why the Allan Herschell Company, Inc., world's largest manufacturer of merry-go-rounds and amusement rides, specify ELECTRUNITE.

For example, Republic ELECTRUNITE 3" Square Tubing is used for the sweeps which radiate from the top of the merry-go-round. Horses and other equipment are suspended from these sweeps, as well as passenger loads.

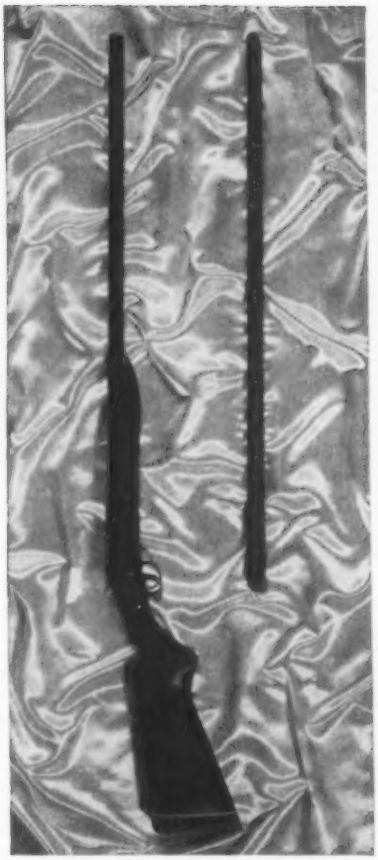
ELECTRUNITE is strong, rugged, lightweight with high strength-to-weight ratios that assure safe, dependable day-in, day-out operation. Because of this lightness and strength, portable amusement equipment built with Republic ELECTRUNITE is easy and economical to set up, take down, and transport.

With Republic ELECTRUNITE, strength, weight, and safety are built-in because ELECTRUNITE is quality controlled from Republic mines, through Republic mills, to manufacturing. ELECTRUNITE is produced from highest quality flat-rolled open-hearth steel, welded by the exclusive ELECTRUNITE process—a continuous electric weld method that unites the wall under pressure without the addition of foreign or extra metal. Tests prove the ELECTRUNITE weld is as strong or stronger than the original base metal.

Republic ELECTRUNITE Tubing fabricates easily, economically, with uniformity. It is available in a wide range of sizes and provides uniform wall thickness, ductility, concentricity, diameter, and other physical and mechanical properties in flanging, flaring, bending, expanding operations.

Let Republic engineers help you select ELECTRUNITE Tubing to meet your many and varied needs. Call your Republic representative or write today.

SOLVE DIFFICULT ASSEMBLY PROBLEMS WITH REPUBLIC HEX HEAD CAP SCREWS, available in a wide variety of steel analyses including ENDURO® stainless, alloy, high carbon (heat treated) and low carbon in sizes suited to all types of precision assemblies. Diameters range from ¼ inch to 2 inches inclusive, with lengths to 12 inches. Fine or coarse threads are provided in each size and material — and other head styles can be furnished on request or order. Write today.



REPUBLIC COLD FINISHED BARS answer the problems of deep-hole drilling, reaming, bore-burnishing, and long-length turning operations for Harrington & Richardson, Inc., leading manufacturers of all types of small arms. Investigate the many Republic Cold Drawn Bar advantages for your operations. Send for data.

REPUBLIC ALLOY STEEL shrugs off fatigue, terrific torque, high impact load, in motor graders built by Adams Division of LeTourneau-Westinghouse Company. The grader's full-floating, two-section drive axle is made of Republic Hot Rolled 4340 Alloy Steel, resists fatigue, is able to take high torque without permanent set. Write today.

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World's Widest Range of Standard Steels and Steel Products

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I would like to know more about:
Republic ELECTRUNITE Mechanical Tubing
☐ Round ☐ Rectangle ☐ Square
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Central Foundry

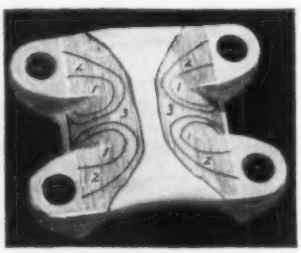
help you design better castings at lower cost

Many new developments here at Central Foundry have broadened the field of application for castings and have given design engineers greater latitude. To assist you in exploiting these new methods and materials to fullest advantage, each of our engineering departments—design, experimental, process and metallurgy—is at your disposal. Central Foundry is also using a number of testing techniques such as stress analysis, cobalt radiography and sonic testing, that have proven invaluable in lowering the cost and improving the quality of castings. These procedures help us to determine the best design and method of producing a casting, either by the green sand method or the shell mold process, and the best material for the casting, either grey iron, malleable iron or ArmaSteel.

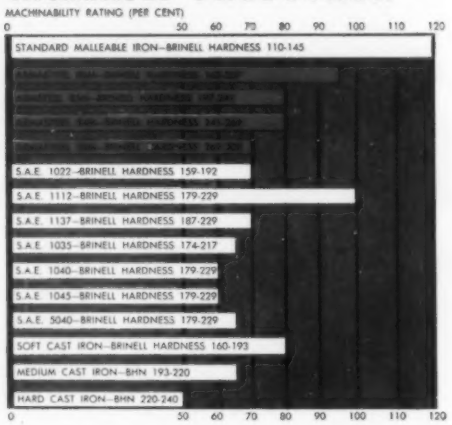
Central Foundry has the capacity to deliver, on schedule, quality castings in production quantities.

STRESS ANALYSIS FOR IMPROVED DESIGN

An important part of our engineering services is the stress analysis laboratory. Stress analysis discovers the amount of stress on a part due to its service function and is an important aid in determining and improving the strength of a part. Improved casting design can be accomplished through the use of stress-analysis by more effectively distributing the metal in the part. The U-bolt anchor plate shown here is a case in point. Our customer was experiencing failures in this part and asked us to see what we could do to solve the problem. Using stress analysis the part was completely redesigned for maximum efficiency. The redesigned part is 35% stronger, 42% lighter and less costly.



EXCELLENT MACHINABILITY FOR INCREASED PRODUCTION



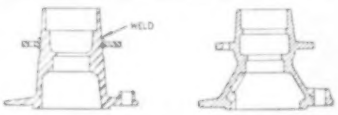
CENTRAL FOUNDRY DIVISION

REDESIGN FOR STRENGTH

This is a rear spring clip pad that was converted to a casting with the help of stress analysis. The clip pad supports the shock absorber arm and clamps the spring to the rear axle of an automobile. When produced as a stamping, this part weighed 4-1/4 pounds. However, when designed as an ArmaSteel casting, weight was reduced to 2-9/10 pounds. Most important, based on comparative stress analysis tests, the casting is *30% stronger* than the stamping. (In addition, the holes are produced by the foundry, making it unnecessary for the customer to punch them.) This conversion from a stamping to a casting resulted not only in increased strength, but in substantial cost savings, as well.

REDESIGN FOR IMPROVED PRODUCT AND ECONOMY

Many of our customers have found that redesigning a product to be made as an ArmaSteel casting rather than as a fabrication, forging or stamping, has resulted in a better part at less cost. The fabricated design of a rear wheel truck hub at the left consists of a forged base with a steel plate welded in place to form the smaller flange. The casting on the right, designed jointly by the customer and our engineers, is of single piece construction, is lighter, stronger and less costly than the fabricated design and eliminates the fitting and welding of the small flange.



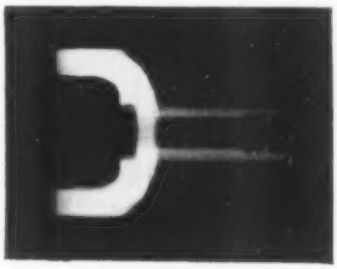
FABRICATED DESIGN ARMASTEEL CASTING

PROCESS ENGINEERING FOR LOWER COST

Our process engineers are continually looking for ways to more economically produce castings, thus lowering the finished-product cost. Shown here is a single casting that combines 5 bearing caps used on a V-8 engine. The casting is almost completely machined as a single piece, and the parts are then separated in a final operation. Substantial savings are realized in both casting and machining costs.

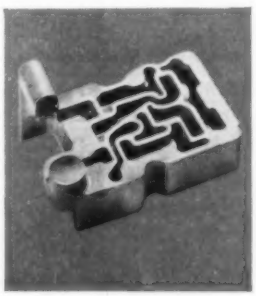
COBALT RADIOGRAPHY FOR ASSURED QUALITY

Radiography, by means of Cobalt 60, has drastically reduced the time required to check castings and is an important aid in obtaining the best possible casting quality. In an effort to eliminate a machining operation on the universal joint yoke shown here, a design change was made in the tube section of the part. When sample castings of the new design were checked radiographically, it was immediately apparent that the design was unsatisfactory since it caused acute metal feeding problems. By redesigning and further checking by radiography, Central Foundry was able to produce, in the shortest possible time, a lighter casting which required less machining in our customer's plant.



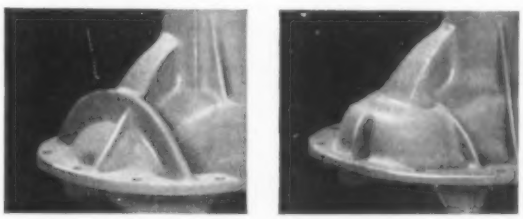
SHELL MOLDING FOR GREATER ACCURACY

Shell molding, a relatively new process of making castings, is now being employed extensively for fast, simple production of complicated castings, such as those requiring narrow, accurate passages and cross sections. It is practically impossible to produce certain parts in any other way without prohibitive costs; this is especially true of ferrous metals. Complicated parts like the manual control valve body shown here, a part of the automatic transmission of a military vehicle, are readily cast in grey iron when the shell process is utilized. The part had been considered as an aluminum die casting, but was thought unsatisfactory because of adverse expansion and wear characteristics. In this case, meeting the requirements for very close tolerances on the thickness and location of ports was made possible by the shell molding process.



REDESIGN FOR WEIGHT REDUCTION

Vehicle weight reduction is a matter of increasing importance to design engineers . . . and more and more existing parts are being converted from a low or medium to a high strength ferrous material such as ArmaSteel. On the left is a grey iron differential carrier currently used in an automobile. By taking advantage of the superior physical properties of ArmaSteel, it was possible to design the part on the right which is *five pounds lighter*. The modulus of elasticity of ArmaSteel is approximately 60% greater (the tensile strength about twice as great) than the grey iron material.



90

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

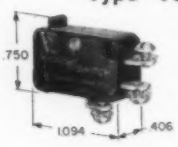
MICRO SWITCH Precision

Here's why you are most likely to find the right switch for your needs at MICRO SWITCH

Type "SM" basic switches—259 variations

Subminiature in size, yet feature precision operation, long life, and high electrical capacity—up to 5 amps., 125 or 250 vac. Catalog 75 gives detailed information on "SM" subminiature switches, including actuators, housings, and assemblies.

Type "V3" basic switches—198 variations

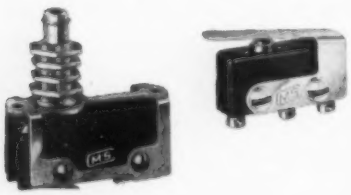


Combine extra compactness with high electrical capacity—up to 10 amps., 125 or 250 vac.—long life, and precise operation. Catalog 74 gives detailed information on "V3" switches and actuators.

The 259 variations are used in the following:			The 198 variations are used in the following:		
112 AUXILIARY ACTUATORS	**153** TOGGLE ASSEMBLIES	**42** ROTARY SELECTOR ASSEMBLIES	**88** AUXILIARY ACTUATORS	**71** TOGGLE ASSEMBLIES	**64** ROTARY SELECTOR ASSEMBLIES
129 METAL ENCLOSURES	**256** PUSHBUTTON ASSEMBLIES	**42** ALL OTHER ASSEMBLIES	**75** METAL ENCLOSURES	**3** PUSHBUTTON ASSEMBLIES	**77** ALL OTHER ASSEMBLIES

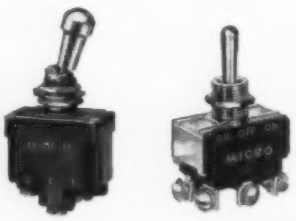
AUXILIARY ACTUATORS

Auxiliary actuators are used with basic switches, singly or in groups, to produce actuation from almost any direction or amount of force. Two examples are shown.



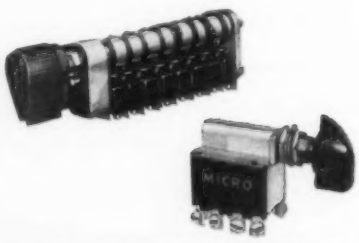
TOGGLE ASSEMBLIES

Many kinds of toggle switch actions are provided by a wide variety of toggle assemblies. Here are two examples.



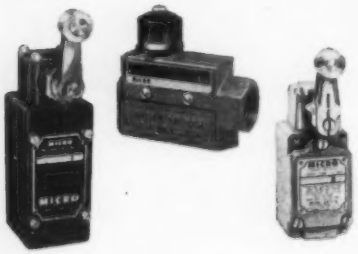
ROTARY SELECTOR ASSEMBLIES

Precise sequential actuation of multiple-switch assemblies is provided by rotary selector assemblies like these.



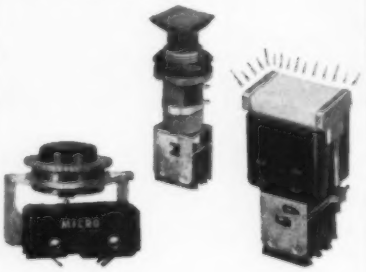
METAL ENCLOSURES

Metal enclosures provide protection from physical damage, sealing against harmful environments, means of mounting and conduit connections. Three examples are shown.



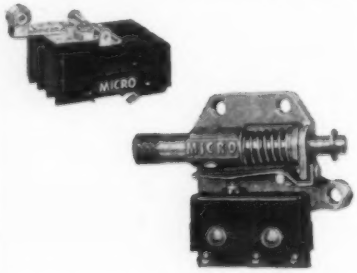
PUSHBUTTON ASSEMBLIES

Lighted pushbuttons, colored buttons, and assemblies for multiple switch operation are available for panel mounting. Here are three examples.



OTHER ASSEMBLIES

Other assemblies include door interlocks with automatic reset feature to assure safety, and single actuated dual mounted switch assemblies. Here are two examples.



Switches have uses unlimited

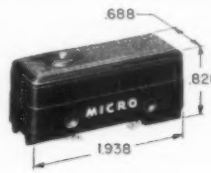
From just six of the basic switches in the MICRO SWITCH line come 7,577 different switches and assemblies . . . for use in machine tools, presses, machinery . . . computers, control panels, instruments . . . aircraft, missiles, launchers . . . to control and limit and guide almost everything in our modern electrical world.

The tabulation does not include our newest "baby"—the "SX"—shown here actual size.

Actual Size

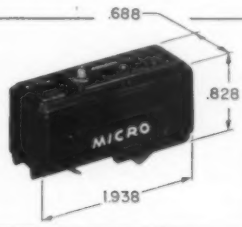
This is the first sub-subminiature, half the size of the famous "SM" subminiature, yet with 5 amp. capacity at 125 or 250 vac, long life and precision operation.

Nor does the tabulation include many basics for special applications, or mercury switches, of which there is a broad line.



Type "Z" basic switches—3,800 variations

Precise actuation and comparatively low operating force and motion. Up to 15 amps., 125, 250, 460 vac. Catalog 62.

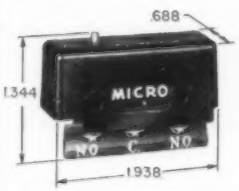


Type "A" basic switches—950 variations

Extra-high electrical capacity—20 amps. steady state current; 75 amps. inrush current—at up to 460 vac. Catalog 62.

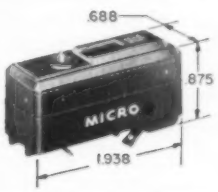
The 3,800 variations are used in the following:		
68 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
765 METAL ENCLOSURES	**16** PUSHBUTTON ASSEMBLIES	**14** ALL OTHER ASSEMBLIES

The 950 variations are used in the following:		
27 AUXILIARY ACTUATORS	**—** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
58 METAL ENCLOSURES	**14** PUSHBUTTON ASSEMBLIES	**16** ALL OTHER ASSEMBLIES



Type "DT" basic switches—78 variations

Highly compact double-pole double-throw switches, with marked terminals providing normally-open and normally-closed contact for each pole. 10 amps., 125 or 250 vac. Catalog 62.



Type "MT" basic switches—67 variations

Long life, high d-c capacity switches—10 amps., 125 vdc—when wired either "polarized" or "non-polarized". SPDT. Offer compact units for flexible control of motors, solenoids, etc. Catalog 62.

The 78 variations are used in the following:		
29 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
62 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**6** ALL OTHER ASSEMBLIES

The 67 variations are used in the following:		
7 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
11 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**1** ALL OTHER ASSEMBLIES

Experienced engineering assistance in switch application in your field is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages. For the right switch—and every switch right—look first to MICRO SWITCH.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd. • Toronto 17, Ontario

Honeywell
MICRO SWITCH PRECISION SWITCHES

DESIGNING WITH ALUMINUM

NO. 29

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

DESIGNING WITH ALUMINUM SCREW MACHINE PRODUCTS

RECENT INNOVATIONS in screw machine equipment have made possible great strides in the accuracy, versatility and output rates of both single and multiple spindle machines. These advancements, such as spindle-stopping attachments, increased spindle speeds and numerous secondary-operation accessories, along with the superior working qualities of improved aluminum alloys, have created new opportunities for the designer of precision, high-volume production parts.

Advantages of the Screw Machine Process

The screw machine process serves two primary design considerations: high quality and low production cost. Thus, whenever design of the parts permits, screw machining is usually chosen in preference to other fabricating methods.

High quality of product is, in part, the result of high quality starting materials. The rod, bar and wire used in screw machine work is wrought during the forming process, thus acquiring good density, low porosity and fine grain structure. These properties are conducive to excellent machinability, faithful detail and fine surface finish.

Materials having these properties, when worked in a process of inherently high accuracy and close control, produce parts of dependable dimensions and great uniformity. Accurate concentricity and mating-part fits are attained, with closer tolerances possible than in any other primary fabricating method. For example, Class 3 threads, and other features of similar fineness, may be turned without undue difficulty.

The properties contributing to high quality also contribute to low production cost. Fewer secondary operations are necessary, because of the fine as-machined surface finishes, the intricacy of detail and the dimensional accuracy possible in the basic screw machine process. Rejection rates are low, and subsequent automatic handling processes are facilitated by the uniformity of the parts.

Reduced unit costs also stem from the wide range of available high speed equipment and mill-standard raw materials, the relative simplicity of machining set-up and the faster delivery of finished parts. Expensive dies and fixtures are not required. And because stock cutting tools generally may be used, tooling and maintenance costs are minimized. In-process modification of parts is relatively quick and easy.

Added Advantages with Aluminum

The designer will find these native features of the screw machine process even more valuable when the physical and mechanical advantages of aluminum are considered.

Fig. 1

TYPICAL PROPERTIES OF ALUMINUM SCREW MACHINE ALLOYS COMPARED WITH STEEL AND FREE-CUTTING BRASS

	Tensile Strength (psi)	Yield Strength (psi)	Shear Strength (psi)	Elongation (% in 2 in.)	Hardness (Brinell)	Modulus of Elasticity (psi)	Density (lb./cu. in.)	Electrical* Resistivity	Thermal† Conductivity	Thermal Expansion (68 to 580 F.)
B1113 Steel (Cold Drawn)	85,000	75,000	—	14	170	29.0×10^6	.283	20.0	360	12.8×10^6
C1018 Steel (Cold Drawn)	82,000	70,000	—	20	163	"	"	"	"	"
B1112 Steel (Cold Drawn)	82,500	71,000	—	15	170	30.0×10^6	"	"	"	"
#271 Brass (Free Cutting)	58,000	45,000	34,000	25	143	14.0×10^6	.307	6.6	800	20.5×10^6
ALUMINUM ALLOYS										
2011-T3	55,000	43,000	32,000	15	95	10.2×10^6	.102	4.8	990	22.9×10^6
2011-T8	59,000	45,000	35,000	12	100	10.3×10^6	.102	4.8	990	
2014-T4	62,000	42,000	38,000	20	105	10.6×10^6	.101	5.7	840	23.3×10^6
2017-T4	62,000	40,000	38,000	22	105	10.5×10^6	.101	5.7	840	23.5×10^6
2024-T4	68,000	47,000	41,000	19	120	10.6×10^6	.100	5.7	840	23.2×10^6
6061-0	18,000	8,000	12,000	30	30	10.0×10^6	.098	3.8	1190	23.5×10^6
6061-T4	33,000	21,000	24,000	25	65	10.0×10^6	.098	4.3	1170	
6061-T6	45,000	40,000	30,000	17	95	10.0×10^6	.098	4.3	1170	
7075-T6	83,000	73,000	48,000	11	150	10.4×10^6	.101	5.7	840	23.6×10^6

*In microhms/cm. at 68 F. †In B.T.U. per inch per square foot per hour.

While almost all aluminum alloys are well adapted to machining, a number of them are especially designed for turn-cutting operations. The wide range of these alloys permits matching the characteristics of the alloy to the working requirements of the part. Some aluminum alloys provide strength properties approaching those of cold-drawn mild steel. Others have machining qualities equal to free-cutting brass. All have good corrosion resistance under proper conditions of use.

Alloy 2011, for example, the most popular aluminum alloy for screw machined products, is an especially free-machining metal with excellent mechanical properties, accepting heavy feeds at high cutting speeds. This alloy, and some of the other aluminum alloys available for the designer's selection of optimum property combinations, is listed in Fig. 1 along with representative brass and steel materials.

Alloy 2017, which like 2011 is one of the most frequently selected aluminum alloys for screw machine work, has somewhat higher ductility than 2011, while retaining good machining qualities.

Strongest of these copper-bearing aluminum alloys is 2024, which can be readily roll-threaded, spot welded and finished to fine surface qualities. It is widely used for durable fittings and fasteners.

The 6061 and 7075 alloys listed in Fig. 1 illustrate the versatility of aluminum for screw machine product applications. Note that 6061, for example, increases five-fold in yield strength from its annealed condition to its T6 temper stage, which is attained simply by heat treating. This 6061 material is readily welded by all methods, may be torch or furnace brazed, and has good resistance to corrosive attack as well as excellent machinability.

Alloy 7075 offers the strength qualities of cold-drawn steel *at one-third of the weight per volume* in an easily machined, spot weldable material.

More Helpful Design Properties

In addition to their qualities of superior machinability and high strength-to-weight ratio, these aluminum alloys offer many other properties helpful to the screw machine product designer.

For electrical usages, aluminum alloys offer conductivity, in proportion to weight, ranging up to double that of electrolytic copper. Similarly, thermal conductivity is higher than in free-cutting brass and three or four times greater than in ferrous metals. This quality affords quick, even distribution of heat, where heat is desired, while providing rapid dispersion of undesirable heat. Thus, aluminum terminals, fittings and other parts designed for screw machine fabrication are of great value in electrical equipment, appliances and other high-volume production items.

Another unique property of aluminum, valuable to many modern designers, is its retention of structural strength at low temperature levels. Aluminum alloys actually increase in tensile strength and elongation, without embrittlement, as temperatures drop. The increasing demand for precision fittings and accessories in liquid-gas fueled missiles, for example, gives great significance to this unusual feature of aluminum for screw machine parts.

Still another valuable design property of aluminum is superior resilience under stress, especially in the stronger alloys, due to low modulus of elasticity. In a component subject to normal operating loadings, not involving excessive impulsive shocks or fatigue effects, the ability, "U," of a metal to absorb energy from tensile or compressive strains may be expressed as:

$$U = V\frac{S^2}{2E}$$

where stress S, in psi, does not exceed yield strength; V is the volume of metal under this stress; E is elastic modulus.

The relative capacity of aluminum to absorb energy may then be observed, for equal volumes and equal elastic strengths, as the simple ratios:

$$\frac{\text{U aluminum}}{\text{U brass}} = 1.36, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 2.91$$

For equal elastic strengths and equal weights:

$$\frac{\text{U aluminum}}{\text{U brass}} = 4.1, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 8.1$$

(Equations derived from values in table below—taken from ASM Metals Handbook.)

Metal	E (psi)	Density lbs./cu. in.
Aluminum (2011)	10.3×10^6	.102
Free Cutting Brass	14×10^6	.307
Steel (B1112)	30×10^6	.283

Variety of Finishes Applicable

Among further advantages of aluminum screw machine products is the great variety of mechanical, chemical and electro-chemical finishes applicable to these alloys. While aluminum screw machining alloys have attractive natural appearance, artificially induced finishes may be preferred or required for many applications.

Decorative effects may be obtained by permanent color anodizing or by applied coatings. Other finishes are used to reduce non-lubricated friction between moving surfaces in contact, to improve resistance against abrasion and corrosion, to provide better adherence of paints or adhesive materials, and for many other reasons. Some of these available finishing processes are described in Fig. 2 on following page.

Some means of corrosion protection may be required when aluminum screw machine products are used in contact with dissimilar metals in a corrosive environment. Various means may be used to provide this protection.

Aluminum Offers Cost Advantages

Further help in solving the designer's problems in production economy is offered by the behavior of aluminum in shop handling and machining. The mill-standard starting materials are available, in broad size ranges, from distributor stocks throughout the country. Providing three times as much volume per pound as heavier common commercial metals, aluminum use reduces freight and shop handling costs for both raw materials and finished products. Natural corrosion resistance reduces or eliminates need for special protective attention under storage.

In the machining process, aluminum materials offer more rapid dissipation of heat, long tool life and greater stability of as-machined finish. The lightweight, finely-divided chips are easy to remove from production parts and machinery. Thus, the advantages of designing with aluminum alloys are found in all phases of cost, convenience, fabrication and function.

What the Designer Conceives... Aluminum Achieves

To help designers make full use of up-to-date developments, the following

Fig. 2

SOME AVAILABLE FINISHES FOR ALUMINUM SCREW MACHINE PRODUCTS

Type of Finish	Name of Finish	Principle Purpose of Finish
Mechanical	Grinding	To remove surface imperfections.
	Polishing, buffing and coloring	To remove surface imperfections and to achieve decorative finish.
	Scratch brushing	To obtain a coarse- or smooth-lined texture.
	Satin finish	To obtain a soft, smooth sheen.
	Burnishing	To impart fine finish to a large number of small parts.
	Sand blasting	To produce a uniform matte surface.
Chemical	Caustic Etch	Decorative "frosted" finish.
	Crystalline chromate	Paint base.
	Chromate-phosphate-fluoride	Paint base.
	Phospheric acid	Paint base.
	Chemical polishing	Bright finish or base for anodizing.
	Zincate	Base for electroplating.
Electrolytic Oxide	Sulfuric acid anodize	Hard, corrosion-resistant oxide film, base for dyed coatings.
	Chromic acid anodize	Hard, corrosion-resistant oxide film.
	*Hard anodizing	Extremely hard, corrosion- and wear-resistant film.
	Electrolytic polish	High light reflectivity.
Electroplating	Chromium plate	Abrasion-resistant and decorative.
	Copper plate	To promote solderability, decrease electrical surface-resistance.
	Silver plate	Decrease surface resistance.
Painting	Paint, lacquer, enamel	Decorative, corrosion resistant.
	*Porcelain enamel	Hard, decorative, corrosion-resistant coatings.

*For use only with 6061 aluminum alloy.

checklists summarize the advantages of modern screw machine production and the advantages of aluminum:

12 Advantages of Screw Machine Production

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.
11. Lower costs for actual production due to high rates of production with available new equipment.
12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

12 Advantages of Aluminum

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating have overcome old problems as galling and binding.
12. Technical literature for designing purposes readily available.

Engineering advisory services and technical literature on conversions to aluminum in screw machining are available without obligation to interested manufacturers. For further information and professional design assistance, inquire through the Kaiser Aluminum sales office listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois. *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

see our catalog in PRODUCT DESIGN FILE or write for copy

KAISER ALUMINUM

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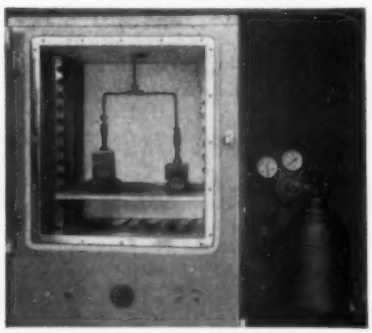
Technical data for gasket design and selection

NUMBER SEVEN

Choosing a gasket for service under high heat, high loads

Where gaskets are used under conditions that combine elevated temperatures and high flange loads—as for example in compressor heads and automatic transmissions—problems of extrusion and torque loss are likely to be met.

If internal pressures are also high, or if contained fluids or gases may attack the gasket—as in refrigeration



Laboratory test checks the combined effect of refrigerant gas and high temperature on Accopac AN-890. Flange at left contains refrigerant at 130 psi; flange at right contains no gas. After initial torquing at room temperature, flanges were heated to 300° F. and torque measured at 24-hour intervals for one week. Test showed no loss of torque on AN-890.

compressors—the service conditions become even more critical.

A new beater-saturated asbestos gasket that will seal under these rigorous conditions has been developed by Armstrong research. It is Accopac AN-890, a blend of refined asbestos fibers and nitrile-type rubber.

AN-890 withstands temperatures up to 800° F. and will not crush or extrude under test loads of 100,000 psi at 300° F. It has unusual torque retention and sealing properties in applications where heat, high flange loads, and high internal pressures are involved.

AN-890 is one of the Armstrong line of Accopac materials. It is available in rolls, sheets, or die-cut parts. For more information, write for a copy of our folder IND-915.

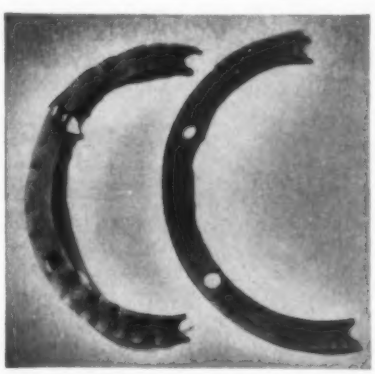
How contained fluids affect the choice of resilient gasket materials

When selecting a resilient gasket material, the possibility of undesirable interactions between the gasket and the contained fluid should be an early consideration.

The action of sealed fluids on a gasket takes two basic forms: *deterioration* and *shrinking or swelling*. Deterioration may result either in leaks or in contamination of the contained fluid. Shrinkage of a gasket, of course, ultimately results in leakage.

Within limits, swelling is not an undesirable reaction in a gasket. In fact, moderate swell can help create a more effective seal since it reduces the minimum flange pressure required for sealing. For example, Armstrong Accopac N-820 requires about 2,000 psi when sealing oil, but will seal a mixture of ethylene glycol and water at flange pressures of around 1,000 psi.

In judging the effect of fluids on a gasket, it is best not to rely on immersion tests of uncompressed samples. Porous materials, which absorb



These gaskets were used to seal hot oil. Ordinary plant fiber material (left) dried out and shrank. Armstrong Accopac gasket (right) was practically unaffected.

rather large amounts of liquid when unconfined, have radically different swelling characteristics when compressed. (See test photo at right.)

The effect of contained fluids can be controlled to some extent by proper design. Such things as bolt load, flange rigidity, and operating temperature should be considered along with the internal environment of the gasket. The maintenance of adequate flange loads, for example, will reduce the risk of fluid getting into the gasket or into the interface between the gasket and the flange.

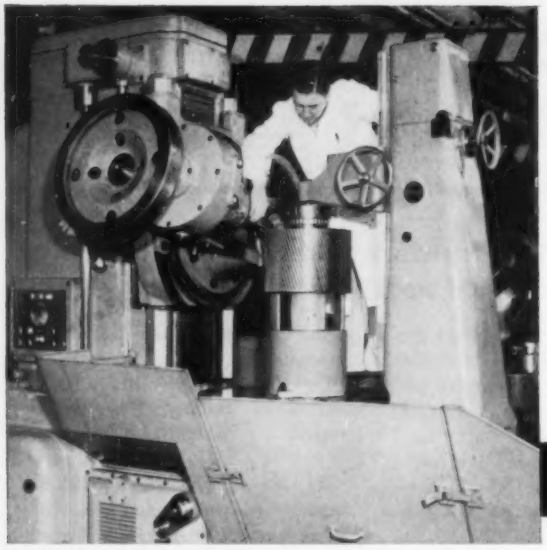
Photo shows difference in swell characteristics of fiber gasket. Test flange was immersed in gasoline. Gasket under compression remains at original thickness; unconfined material at edges swells to over twice original thickness.

Information on the effect of contained fluids on specific classes of gasket materials is contained in the Armstrong Gasket Materials catalog. Data on design factors related to gasket selection is available in the new Armstrong Gasket Design Manual. Write for your copy of either—or both—of these books today.

For your copy of Gasket Materials catalog or new Gasket Design Manual, write to Armstrong Cork Company, Industrial Division, 7112 Irvin St., Lancaster, Pa.

Armstrong GASKET MATERIALS

. . . used wherever performance counts



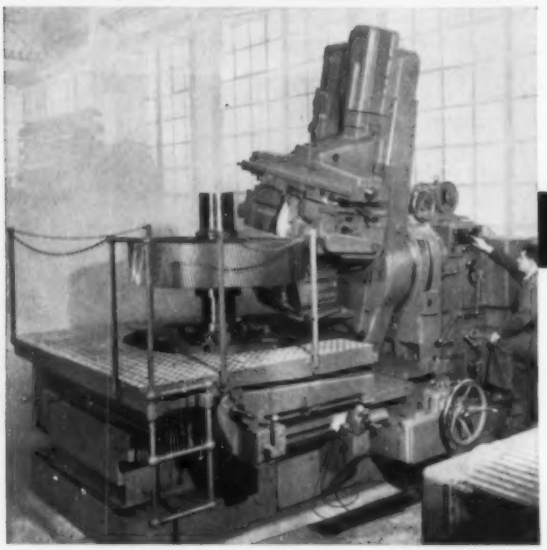
HIGHEST QUALITY GEARS

Now Super-Precision Ground Tooth Gearing up to 72″

by phillie gear

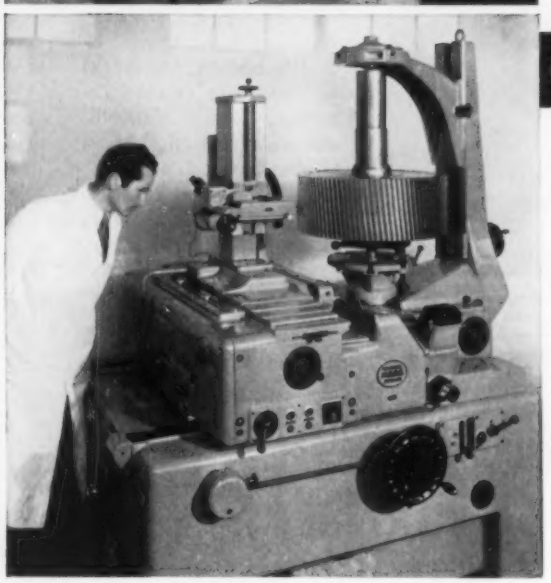
CUT ACCURATELY

In addition to 66 years experience and 3 large, modern plants, Phillie Gear has the World's latest and finest machines for producing gears . . . Special attention is given to selection of materials, machining, heat treatment, and tolerances—all with one thing in mind: to give you the *Highest Quality Possible.*



GROUND ACCURATELY

Illustrated is our latest gear grinder for Spur and Helical Gearing up to 72″ diameter . . . the ultra precision work table is certified accurate to 4.3 arc seconds total accumulative error . . . this custom built machine is the most accurate large gear grinder in America. High Precision Gears ground on this machine open new horizons of accuracy and performance of large gearing for Radar, Marine, Turbine and many similar applications. Phillie Gear has five additional High Precision Gear Grinders.



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All gears made by Philadelphia are analyzed on modern testing machines—and then must pass the most rigorous inspection by specially trained men, before shipment—There is no "guesswork" at Phillie Gear.

Phillie Gear is licensed to manufacture World famous Maag designed precision gear products.

Send for our latest 72 page "Gear Book"—it's practically a treatise on the subject of gears . . . Please use your Business Letterhead when requesting a copy.

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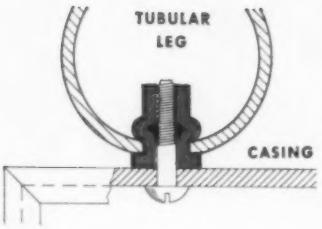
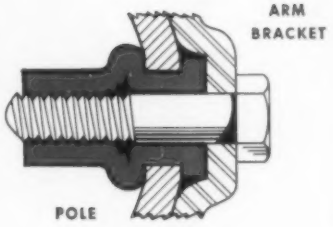
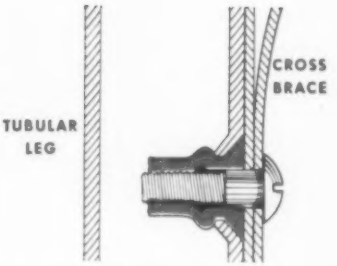
Only B.F.Goodrich Rivnuts® solve all these fastening problems so well



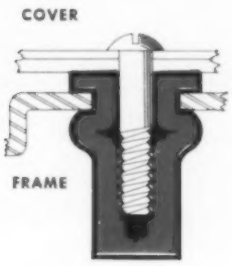
One man installs Rivnuts from one side in seconds—speeds assembly of *barbecues*. Permanent nutplates in legs save time in faster knockdown, too.



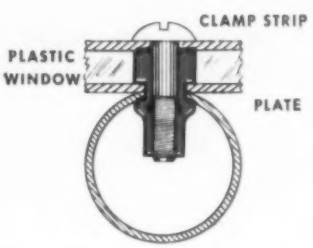
One man does the work of two, assembling arm brackets on *light poles*. Tests show pole or arm will fail before Rivnuts.



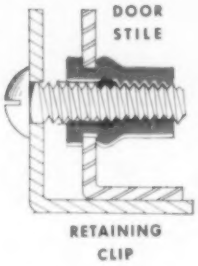
Clean, functional lines of modern *furniture* are preserved by Rivnuts. Upset inside tubular legs, they replace unsightly nuts, bolts and screws.



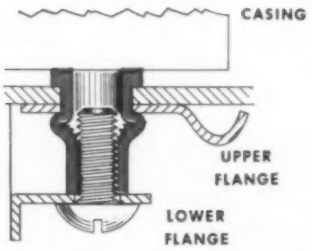
Rivnuts enable repair men to remove top of *automatic washer* and replace it easily. And Rivnuts can be installed after enamelling.



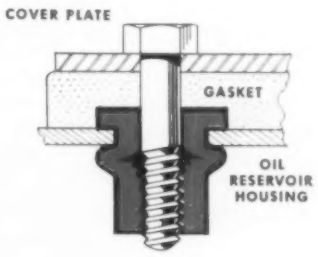
Upset Rivnuts secure *airplane window* plate to center post. Bulges in shanks seal out weather. Heads of Rivnuts serve as spacers for plastic window.



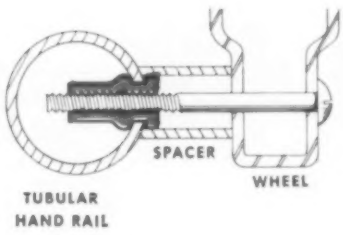
Rivnuts replace self-tapping screws used to hold retaining clips on aluminum *storm doors*, provide firm nutplates that won't loosen with shock or vibration.



Rivnuts eliminate need for reinforcing plates in *vaporizers*. In addition, Rivnuts space bottom flange automatically, prevent bending.



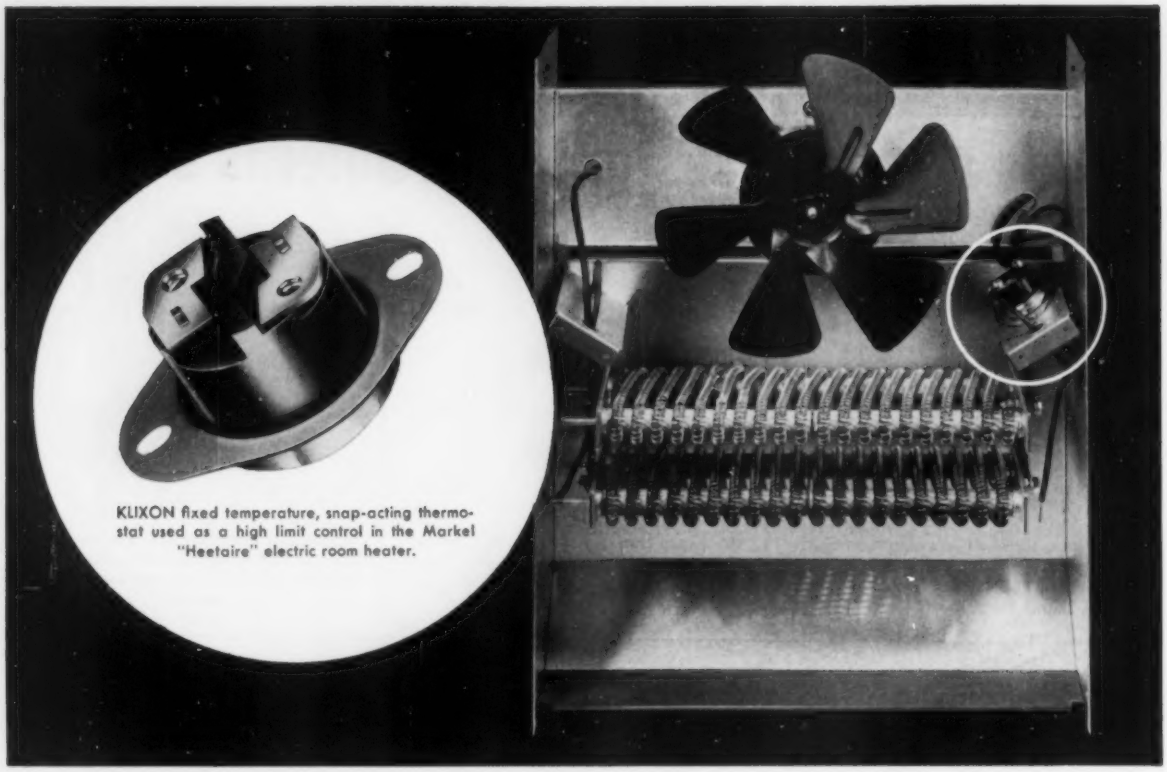
Assembly time for *oil reservoirs* is cut in half. Rivnuts eliminate welding, tapping and cleaning previously required to attach coverplate.



Wheel chair designers needed a blind nutplate with at least 6 clean threads. Rivnuts, only one-piece blind rivets with threads, were the answer.

Special fastening problems? B.F.Goodrich Rivnuts solve them. Send for free demonstrator. Dept. PE-128, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.

B.F.Goodrich ***aviation products***

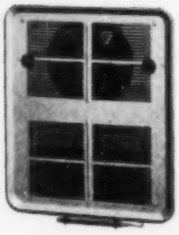


KLIXON fixed temperature, snap-acting thermostat used as a high limit control in the Markel "Heetaire" electric room heater.

KLIXON Snap-Acting Thermostats

used for High Quality and Reliability in

MARKEL Heaters



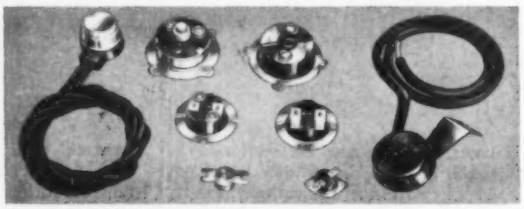
Modern in design, compact for space saving, "Heetaires" are manufactured by Markel Electric Products, Inc., Buffalo, New York, a leading producer of high quality electric heating equipment for over 30 years.

To insure dependability of control, Markel uses KLIXON Snap-Acting Thermostats in their heaters. Here's what they have to say about KLIXON Controls . . .

"We use KLIXON *Controls because we feel that they are consistent with the high quality and reliability of our Markel heaters."*

Markel Electric Products, Inc. is another of the hundreds of leading manufacturers specifying and using KLIXON Controls. These controls are available in both sealed and open construction in a wide variety of types and sizes. Fixed temperature settings are custom calibrated at the factory to meet the customer's requirements.

Competent Spencer Division engineers at the factory and in the field will help you make test applications of KLIXON Controls at your request. Send for literature on the new KLIXON 204 Series Thermostats and get acquainted with the application possibilities on your products.



Typical KLIXON Snap-Acting Thermostats used in many applications by original equipment manufacturers.

METALS & CONTROLS CORPORATION

Spencer Division

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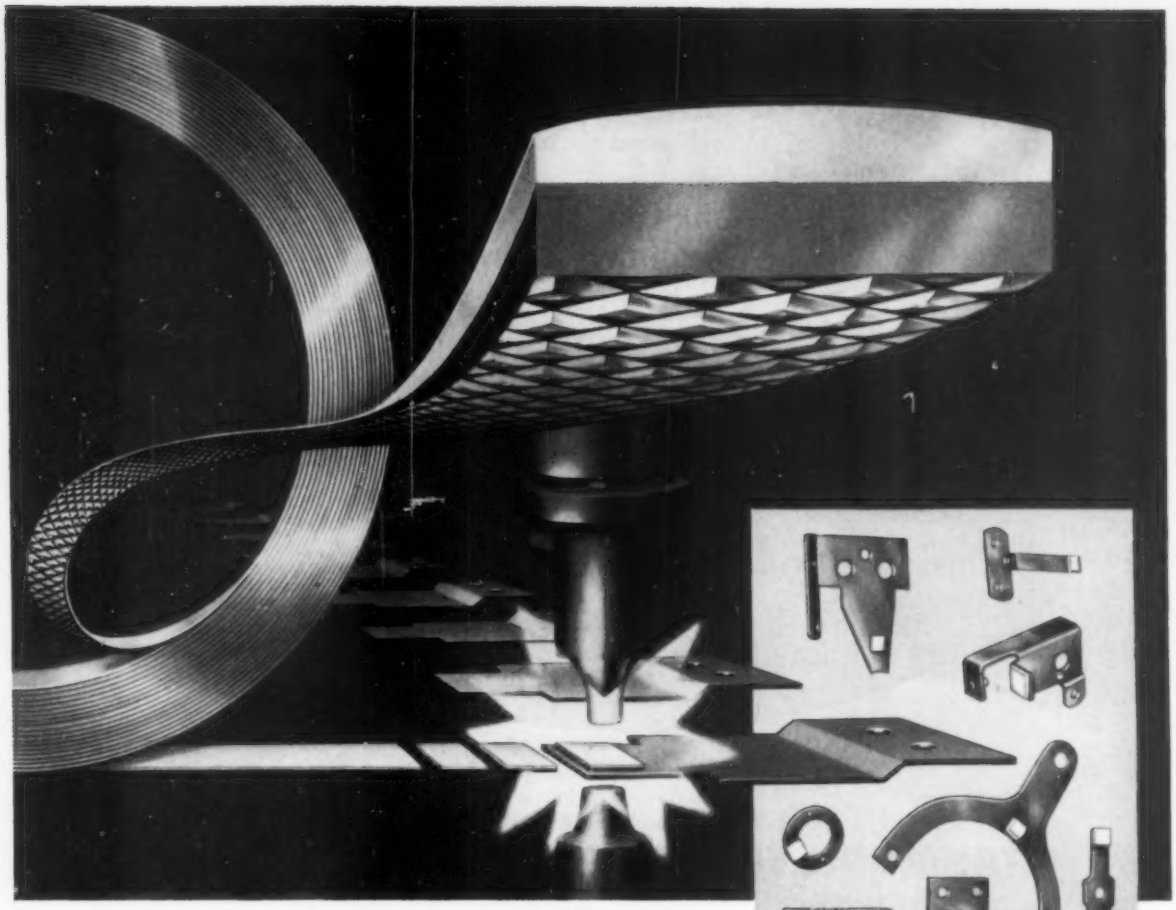
KLIXON®



Now with General Plate Electrical Contact Tape... You Can

SAVE UP TO 40%

On Contact Cost

In addition . . .
Contact Tape permits:

- **Broader latitude in contact assembly design**
- **Smaller contacts for same electrical loads**
- **Weight-saving**
- **Simpler material handling**

General Plate Electrical Contact Tape can be applied to any large-volume contact design, permitting the automatic assembly of two or more parts in a single operation.

Tape contacts are easily attached by spot welding methods. They are self-aligning . . . allow broader assembly tolerances. Because of this, tape contacts reduce assembly costs and eliminate or reduce adjustment time.

Tape contact material is supplied in long continuous lengths which simplify material handling.

In addition to supplying clad electrical contact tape material, General Plate is equipped to weld contact tape sub-assemblies for you.

Design engineers are invited to make use of General Plate contact engineering services . . . for material selection . . . parts design . . . samples.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate electrical contact tapes, as well as other clad contacts, can be put to work for you.

METALS & CONTROLS CORPORATION

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This design calls for a high temperature alloy bar to be bent and flash-welded into a ring. When it is machined to cross section, as much as 40% of the metal is machined away.

In a part like this, you really end up with nothing more than the core of the bar with which you start . . . which was once the core of an ingot.

That is why, in almost every case, poor service or high reject rates in parts like this can be traced to inconsistency in the ingot. You get a good part *only* when the steel ingot itself is consistent through the core all along the centerline. That's what MEL-TROL gives you.

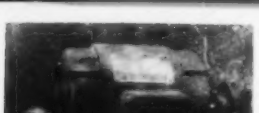
MEL-TROL achieves greater uniformity in ingots than any other known system of steelmaking today. It is a process combining an exclusive, patented ingot mold design with an integrated system of quality controls. The result is the most complete freedom from variation in toughness and strength between surface material and the ingot core ever attained in commercially available high temperature alloys.

Mechanical properties at both room and elevated temperatures are also more consistent than in conventionally made alloys. When you specify MEL-TROL alloys, you're specifying—and insuring—the best performance you can put into high temperature parts. The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.
Webb Wire Division, New Brunswick, N. J.

Two revolutionary insulating techniques developed and pioneered by Allis-Chalmers



New motor development obsoletes today's application practices!

Only from Allis-Chalmers!

***Super-Seal* motors save up to 60%**

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line—an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalies that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from two distinct revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate a *Poxeal* stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more by reading the next pages; then contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

A-C **ALLIS-CHALMERS**

518 9180

easily meeting Class H temperature

CHRYSLER KIMBERLY-CLARK GOODYEAR

SOUTHERN CEMENT CONTINENTAL CAN

SCOTT PAPER

Two revolutionary insulating techniques developed and pioneered by Allis-Chalmers mean savings of millions of dollars for motor users . . .

New open motors are unaffected by moisture and contaminants

Modern insulating materials and new methods of application, now available in *Super-Seal* open-type motors, are drastically changing motor application standards. These insulations are so completely impervious to moisture and contaminants that *Super-Seal* open motors can be used in most applications formerly requiring costly enclosed designs. Existing applications have resulted in savings as high as 60%.

Basic insulation systems

Larger *Super-Seal* motors with form-wound stator coils use the *Silco-Flex* insulation system. Heart of this system is a remarkable rubber-like silicone elastomer, applied in semi-cured state and vulcanized to form a void-free, impervious dielectric barrier. More than four years of development and field testing have proven the superior electrical and physical properties of *Silco-Flex* insulation systems.

Stator coils of smaller random-wound motors are protected by equally effective *Poxeal* insulation system. A tough, durable case of epoxy resin completely seals the winding end turns and slot portions. Bonded to the stator laminations, it forms a seal completely impervious to contaminants.

Moisture resistance

In addition to being void-free, the silicone elastomer used in *Silco-Flex* insulation is moisture repellent. Even in high humidity, moisture does not form a surface film of condensation. Coils with this protection can operate completely immersed in water. In fact, one of the recommended cleaning procedures is use of detergent and water.

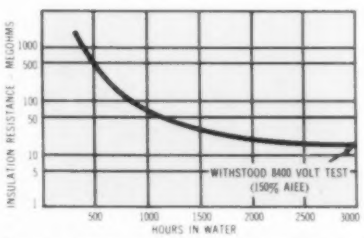


Fig. 1—Test curve shows insulation resistance of *Silco-Flex* insulation while immersed in water.

Moisture resistance of *Silco-Flex* coils is demonstrated in Fig. 1. After more than 3000 hours of total immersion with 2300 volts impressed on the coil, the test was terminated when it became apparent that little more drop could be expected in the coil's insulation resistance. At that point the coil still withstood a high potential test of 8400 volts without injury.

Encapsulated stator windings are equally well sealed. Motors with *Poxeal* insulation protection have been thoroughly tested under water while operating with full load and full voltage.

Resistance to contaminants

Silicone elastomers and epoxy resins are relatively inert to attack by practically all reactive agents. Further, the void-free construction of insulation systems used in *Super-Seal* motors prevents penetration of contaminants. As a result, *Super-Seal* motors are unaffected by oils, most acids, salt solutions, alkalies, and oils and are ideally suited for such applications.

Thermal stability

Temperature-wise, *Silco-Flex* insulation can easily withstand hot-spot temperatures of 200 C and more—

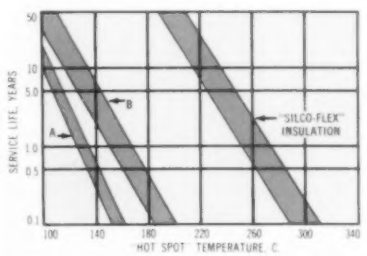


Fig. 2—Chart shows that *Silco-Flex* insulation more than meets Class H requirements.

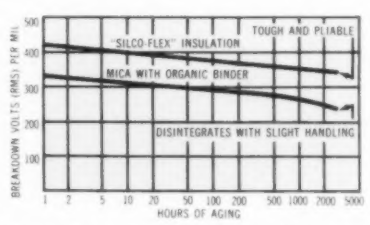
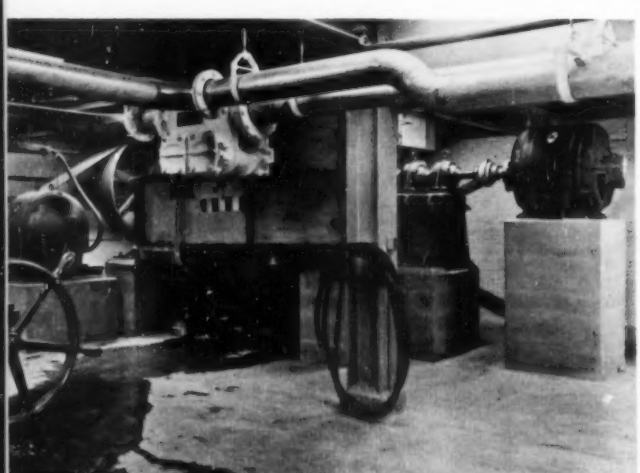


Fig. 3—Tests of 2300-volt insulated bars show thermal stability of *Silco-Flex* insulation.



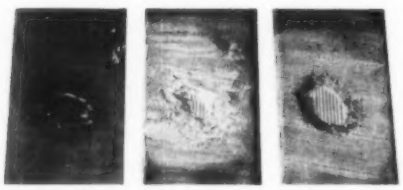
Paper mills have wide application for *Super-Seal* motors because of moist atmospheres.

easily meeting Class H temperature requirements (Fig. 2). At temperatures where the life of Class B coils would be measured in weeks, the life span of *Silco-Flex* coils is well beyond machine obsolescence.

Comparison with a mica-organic binder insulating system (Fig. 3) offers further proof of thermal stability. After 2000 hours of aging at 200 C with 8500 volts applied continuously, the *Silco-Flex* insulated coil was still tough, pliable, and completely serviceable. The mica-taped insulation had deteriorated to the point where it disintegrated readily and was completely useless.

An added advantage of *Silco-Flex* insulation is unusually high thermal conductivity — about twice that of conventional insulations. This means heat dissipates faster from its point of generation.

Poxeal insulation also demonstrates remarkably good thermal stability. Materials now in use are suitable for Class B temperatures, although actual classification of the insulation is determined by the basic material used.



Silco-Flex Insulation | Polyester Mica Tape | Asphaltum Mica Tape

Fig. 4—Samples of motor insulations after sandblasting give comparison of abrasion resistance.

Abrasion resistance

Resistance to abrasion is still another point of superiority in the insulation systems used for *Super-Seal* motors. Abrasion resistance of *Silco-Flex* insulation is compared to other types of insulation in Fig. 4. After one minute of sandblasting with 90-grit aluminum oxide and 100-psi air, only slight surface erosion appeared on the *Silco-Flex* sample. Other insulations were eroded to bare copper.

Application practices obsolete

The superior qualities of *Super-Seal* insulating systems, developed by Allis-Chalmers, make it necessary to reappraise present application practices. With virtually ageless insulation, *Super-Seal* motors assure more reliable service and require less upkeep than the best protected, conventionally insulated machines — and at considerably less cost.

Super-Seal, Poxeal, and Silco-Flex are Allis-Chalmers trademarks.

CHRYSLER KIMBERLY-CLARK GOODYEAR SOUTHERN CEMENT CONTINENTAL CAN SCOTT PAPER AMERICAN OIL CELOTEX FORD HURON PORTLAND CEMENT FIRESTONE PACIFIC GAS & ELECTRIC STANDARD OIL OF INDIANA B. F. GOODRICH DOW CHEMICAL MARLEY INGERSOLL-RAND LINK-BELT

WIDE ACCEPTANCE

of Super-Seal motors proves their advantages

Cement, petroleum, chemical, steel, mining, paper, utilities, municipalities and general industry — outstanding corporations in every field are specifying *Super-Seal* motors wherever operating conditions are tough.

Cost and *superior insulation* aren't the only reasons. Users are getting MORE MOTOR, too. Here's why:

Standard totally-enclosed motors, 55° C rise, have a *service factor of 1.* In other words, "nameplate" horsepower is the maximum. A 40° C rise *Super-Seal* motor with *Poxeal* insulation, and a 60° C rise *Super-Seal* motor with *Silco-Flex* insulation have a *service factor of 1.15.* For comparisons on what this difference means in required motor sizes, see this chart:

Rated Horsepower (Maximum Hp, TEFC)	Maximum Continuous Hp—*Super-Seal* Motor
15 hp	17.25 hp
25	28.75
40	46
75	86.25
125	143.75
200	230
350	402.5
500	575

Join the swing to *Super-Seal* motors. It will pay dividends fast. Contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

ALLIS-CHALMERS

SOUTHERN CALIFORNIA EDISON LONG ISLAND LIGHTING AVCO UNION BAG UNIVERSAL ATLAS UNION CARBIDE OHIO OIL INTERNATIONAL PAPER SOUTHERN PACIFIC PIPE LINE ALCOA ROHM & HAAS ARMOUR SHELL OIL COMMONWEALTH EDISON OWENS-ILLINOIS WYANDOTTE CHEMICAL BETHLEHEM STEEL ALLEGHENY-LUDLUM MEAD DU PONT DETROIT EDISON ESSO HERCULES POWDER SINCLAIR PIPE LINE GENERAL TIRE MONSANTO

This *SUPER-SEAL* MOTOR application SAVED $3000!

Find out how much you can save

This application of a *Super-Seal* open-type motor — in place of a weather-protected design of the same rating — *saved the user $3000.00!*

You can achieve similar savings! Fill out the data sheet below and *find out for yourself how much you can save — on a "no-strings-attached" basis.*

Here's what to do: 1) Select an enclosed motor application in your operations (a new motor need or, for comparison, a motor just purchased); 2) fill out the data sheet; 3) mail to the address shown.

We'll give you a cost quotation on a *Super-Seal* open motor for that application.

Fill out this data sheet—

no strings attached—to find out how much you can save on a new motor or on an existing motor installation

To: **ALLIS-CHALMERS**
888 S. 70th St., Milwaukee 1, Wis.

Motor Data

1. Type (i.e., squirrel cage):

Horizontal ☐ Vertical ☐

Hp ..... Rpm .....

2. Phase ..... Frequency .....

Voltage .....

3. (For synchronous only)

Power factor .....

Starting torque .....

Pull-in torque .....

Pull-out torque .....

Application Data

4. Description of application:

5. Drive: Direct-connected ☐

V-Belt ☐ Other: .....

Starting load .....

Ambient temperature .....

6. Operating conditions: .....

Dirty ☐ Clean ☐ Wet ☐ Dry ☐

Other .....

Information on Existing Motors

(for comparison)

7. Type of insulation

Type of enclosure

Time rating .....

Temperature rise .....

Bearings:

Anti-friction ☐ Sleeve ☐

8. Special characteristics or construction:

NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

A-5869

ALLIS-CHALMERS

DEVELOPMENTS TO WATCH...

Custom-tailored ceramics . . .

. . . and electronic materials may come from irradiation studies now underway at Oak Ridge and other AEC laboratories.

While the primary aim of most of these studies is to discover and overcome radiation damage, they may also provide a path to improved materials for special applications.

For instance, it has been found that diamonds and silicon carbide, like graphite, store energy under neutron bombardment. This energy storage has created serious problems in reactor operation; but it might be a useful property elsewhere. Likewise, under irradiation some of the harder materials like diamond and quartz tend to soften and expand, and softer materials like mica and plate glass get harder—again, undesirable effects in reactors, but not necessarily in other applications.

Another possibly useful effect is the increase in thermal conductivity of mica; and the marked decrease in thermal conductivity of spinel and porcelain. On exposure to intense irradiation, mica shows a 50% increase in thermal conductivity; spinel and porcelain, a 50% to 60% decrease. In many cases, electrical conductivity is altered by irradiation.

Magnesium wheels for cars and trucks? . . .

. . . For trucks, at least, they may be close at hand. As John A. Main of Kelsey-Hayes points out, magnesium wheels can save at least 50% in weight without loss of strength; and the trucking industry is becoming increasingly weight-conscious. Some commercial trucks already have forged aluminum wheels, and truck users are on record as saying each pound of weight is worth a premium of $1.

In the passenger-car field, Main admits, "we have no indication that car manufacturers are willing to pay a premium for light wheels." Though aluminum wheels have been made and used, he says, "their design was predicated on appearance—not function. In fact they weighed more than the steel wheels they replaced."

Before magnesium can move into passenger cars, then, material and processing costs will have to come down, and performance or styling advantages will have to be more clearly demonstrated. One possible route: development of a satisfactory finish for magnesium which would allow dispensing with wheel covers and permit a style change as well as a cost saving. The electroless nickel process looks promising, he says, but further tests are necessary.

(For more news of magnesium, see *PE*—Nov 10, p 39 and Nov 24, p 21.)

Speed-reduction pulley . . .

. . . designed in England, features an unusual method of keying the planet pinions to their shafts: liquid nylon injected after assembly and allowed to harden in place. The advantage, says Furnival & Co Ltd, Reddish, Stockport, is that the gears are permanently assembled, but the elasticity of the nylon allows each to take up its natural position, eliminating the problems that arise in fitting several gear trains to a central gear.

To inject the nylon, a special molding machine is used, and the pulley itself serves as the mold.

The *Andantex* pulleys themselves, featuring helical gears of nickel-chrome steel and steel bearings, are designed for mounting directly on the driven shaft. They can be made in sizes from 4 to 80 hp, at costs ranging from about $115 to $2500 (US equivalent).

Nylon, molded in place, keys the gears in this newly designed speed-reduction pulley, permits use of a wide range of gear combinations.

DEVELOPMENTS

TO WATCH...

New thermal batteries . . .

. . . are promised by Naval Ordnance Laboratory—result of a development program that will aim at improved liquid as well as new solid types. Already the proud parents of one new battery, the small-but-powerful lead-silver oxide cell (*PE—May 12, p 72*), NOL is anxious to find others with special properties for ordnance equipment. The thermal battery, for instance, is one which lies dormant until heat is applied, its electrolyte in solid form. Then, as temperature rises, the electrolyte melts, and the cell goes to work. Navy plans to use it in fuzes and other ordnance equipment.

Solder for titanium . . .

. . . that will produce joints with "greater than 40,000 psi" tensile strength has been developed by Curtiss-Wright's Research Div, Quehanna, Penna. Furthermore, says C-W, flow temperature of the solder is between 1300 and 1400 F, well below those previously available, and it is expected to be less expensive.

Though specifically formulated for low-temperature torch joining, and for use with a special flux, this silver-based solder can also be applied by vacuum furnace or inert-atmosphere methods.

The flux itself is formulated to melt at about 1000 F; but can be heated to 1500 F without decomposing, C-W says. Furthermore, it's translucent at the working temperature, and can be removed with a water-acid dip.

Data processors weighing only 175 lb. . .

. . . yet capable of adding 30,000 ten-digit numbers a sec, are being developed for the Signal Corps as part of its over-all effort to provide continuous information under battle conditions (*PE—Sep 8, p 5* and item below).

One unit, being developed by IBM, is characterized as a "solid-state mass-information processing system of advanced design." It will feature modular construction and built-in error-checking devices; and is expected to be able to withstand the shock of both air and truck transport.

Another system, for which a contract has been awarded to Philco, will be made in two versions—one with a larger storage capacity than the other. The smaller unit is expected to meet the weight limit; but even the larger one has to fit in a space 11 ft long, 6½ ft wide, and 6 ft high, while providing "constant, reliable and error-free operation."

High-speed teleprinter . . .

. . . that "shoots letters at paper electronically," using a bank of electrode "guns," and "can fire any letter or number" as desired has been developed by Burroughs Corp.

Said to be 50 times faster than the standard news-service teletypewriter, it can type out messages at the rate of 3000 words a minute.

Printing is by an electrostatic recording technique, in which each line of text is "printed" by means of powdered ink picked up electrostatically and "fixed" by passing over a heated roller.

This unit, one of a series being developed by and for the Signal Corps (see above), is said to be capable of replacing a bank of eight standard printers; and, says the Army, in mass production it should cost less than half as much. —ARG

Army's new teleprinter is neatly styled, desk-size unit, operates from standard code tape or from long-distance radio and telephone circuits.

Publicize the Engineer?—Yes, but How?

• It's not a new problem, but many think much of the publicity given the "scientist" should have said "engineer."

• Is an engineer who doesn't belong to a society just a "technician," and not a professional man?

• The Medical Association spends $1.2 million each year for publicity; engineers?—little more than one-tenth that.

NEW YORK—Some time, some place, someone will put his finger on the correct approach to publicizing the engineer and the engineering profession. But so far no one has the answer to the problem right now.

This is a fair appraisal of the feelings of the various engineers, technical editors, public relations men and various committee men of the engineering societies who met recently at the Engineers Club here under the auspices of the Engineers Joint Council to discuss the place of the engineer in the public media of this country. In fact, one person threw out this challenge to the people in the societies responsible for setting the publicity tenor for the profession: "When you find out what you're going to do, let me know."

Leo E. Brown, Public Relations Director of the American Medical Association said, "The engineering profession won't succeed in raising its status in the eyes of the public until it starts thinking of the customer instead of the engineer." Brown also said that many public relations projects should be developed in terms of public service.

Enoch R. Needles, president of the Engineers Joint Council, said his group is in process of setting up a series of advisory boards on subjects of national interest that will report directly to an agency in Washington. The first advisory board to be formed will study the national transportation problems. Mr. Needles said the plan is still in the discussion stage with Washington and that the problem is at the moment in the office of Dr. James Killian (Scientific Advisor to the President) awaiting decision as to what agency the EJC advisory group will report. When completed, the reports will be available to members of government for study.

The idea behind the program is to get the engineer before the public eye, more than he has been. The scientist has been played up enough, it is felt, in fact too much. The word "scientist" has been tacked onto everything coming out of Washington these days, when frequently the term "engineer" should have been used. "Science" advisory committees have been formed by the score, but what about the engineer?

Needles said the group on transportation is just a start. Once this has been shown to be successful in bringing out the basic facts on which legislation can be based, there will be more.

Several members of the audience thought that it was belaboring the issue to expend all this effort to promote the term "engineer" where it should be used, and not allow the "scientist" to soak up all glory. One engineer, who said that he works daily with chemists and physicists on his job, said the idea that there should be any distinction never entered his mind. "We're all working toward the same goal," he said, "and that is the success of our project."

Another who felt that fighting for such a distinction was unnecessary, said that engineers are riding along the crest of a technology wave, and that it makes no difference who is responsible for it. The technical field benefits.

This line of reasoning brought forth another approach that maybe the engineering societies should promote the word "technologist" instead of "engineer." This term would then be all encompassing and would not require further explanation to the public as to the meaning of: mechanical, electrical, chemical or metallurgical engineer.

SOCIETY MEMBERSHIP A SORE POINT

When someone asked how the engineering societies could claim to promote professionalism in the engineering fraternity when no more than one out of every three college graduate engineers now pursuing that line of business actually belongs to any one of the societies, several people bristled. Mr. Needles said he doesn't consider a man an engineer and worthy to call himself a professional man unless he does belong to one of the engineering societies. "Any non-member I regard as no higher than a technician," he said, "since he apparently doesn't think enough of his profession to work at it from an organizational standpoint to promote it." This leaves to speculation the point that the remaining two-thirds of the engineering fraternity are either of nonprofessional caliber, or that they just don't like the societies.

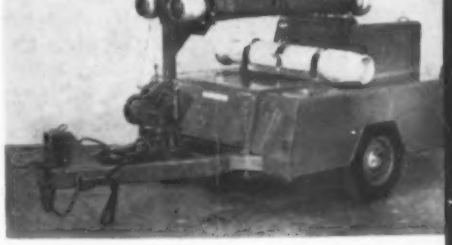
AMA SPENDS FOR PUBLIC RELATIONS

Mr. Brown said the AMA spends around $1.2 million each year for its public-relations activities. As a means of comparison, here are the publicity budgets of several engineering societies (approx): ASME, $40,000; AIEE, $25,000; AICE, $18,000; AIChE, $10,000. The Engineer's Joint Council's publicity expenditure, which is made up of contributions from the various societies, totals $6,000. A good guess places the publicity figure for the National Society of Professional Engineers at about $30,000.

The answer to the obvious question

Portable firefighter . . .

with a submersible pump has been developed at the Corps of Engineers R & D Labs, Fort Belvoir, Va. The pump (white unit on trailer) is capable of 1500-gpm output at an 87-ft head and can be driven by a 60-kw, 60-cycle, 440-v engine-generator set. The pump weighs about 550 lb, and is 68 in. long. It will be connected to special 8-in. hose being developed, which will connect to lightweight, quick-coupling pipe to carry the water to the fire pumps. A second pump of this type can serve as a booster. (See Sept. 15, p. 80, for design data on submersible motors).



of where the AMA gets that kind of money for publicity purposes is this: the AMA has 270,000 members from which it gets $25 a year.

Brown vehemently denied the AMA is in a position to tell the various medical schools how many students they should admit each year in order to control the number of MD's entering the profession. He added the association is always interested in raising the educational standards of the profession—it feels that this is a significant factor in maintaining the status of the medical profession.

He said that the AMA is made up of 53 state federated societies and 1800 county medical associations. Each state group is completely autonomous. While the doctor does not have to belong to the national organization (he usually does), he must meet certain standards of the local medical groups before he can practice. Total membership fees for all local, county, state and federal organizations range from $75 to $150.

US Machine Tool Builders OK Int'l Symbols for Control Panels

NEW YORK—A committee representing leading US machine tool builders has agreed on a set of symbols for machine-control panels (see right), has gotten approval for them from the American Standards Association, and the matter is now being considered by the International Standards Organization. This word came from C. T. Blake, director of engineering at Warner & Swasey Co and chairman of US subcommittee of the ISO/TC 39 working group, who spoke during the 40th annual ASA Conference on Standards here.

US interest in the standardization of machine tool control began in Oct, 1957 when Blake attended an ISO/TC 31 meeting in Paris where he learned that Germany, Hungary, and France were compiling a list of symbols for consideration by ISO member nations. He returned to determine interest among US machine tool builders for such a project; there was plenty. Blake then formed a committee of representatives from Barnes Drill Co, Landis Machine Co, Gisholt Machine Co, Cincinnati Milling Machine Co, Blanchard Machine Co, Thomson Grinder Co, E. W. Bliss Co, Michigan Tool Co. and Warner & Swasey.

The group had until June of this year to submit proposals to ISO at Harrogate, England. Blake and his group wanted more time to work out a comprehensive list of symbols so via their delegate, A. W. Meyer of Brown & Sharpe, ISO was requested to grant the American contingent more time. This extension would be used to study further the symbols proposed by the French Standards Association.

In addition to the regular meeting at Harrogate (*PE*—July 7, p21) the ISO/TC okayed Meyer's request for time but stipulated that any suggested changes in the AFNOR proposals would have to be thoroughly justified.

At the recent ASA meeting here, Blake announced that the US proposals for a set of symbols had been approved by the ASA and were being forwarded to the French Secretariat for approval of the ISO membership. Considerable time and effort were spent by US committee members who canvassed the industry for ideas, suggestions.

All in all, there were relatively few instances where US and French approaches to the symbol problem clashed. And where they did, Blake believes that compromises can be engineered.

Some 80 different symbols were proposed originally by ISO. Blake's committee has suggested 14 new ones. The committee assumed that operations would be machine-oriented, and then in choosing symbols kept in mind that the less words the better, the simpler the better, and the more distinctive the better.

Symbol	Iso Proposal	US Proposal
Start	I	
Stop	STOP	STOP
Neutral	(none)	
Emergency stop	Red	Red STOP
Emergency return	(none)	Yellow
Feed	1/x 1 1xy	fine normal rapid
Spindle (turning)		Pictograph of particular spindle
Spindle rotation		
Select, pre-select	(none)	
Automatic select		

Predicts 7th Decimal by '68

NEW YORK—Measurement accuracy of a tenth of a millionth of an inch will probably be attained in the US within the next 10 years, it was predicted by Louis F. Polk, president of Sheffield Corp, during the above-mentioned ASA conclave.

Polk pointed out that some plants today are manufacturing grinding, honing, and other machine tools and measuring equipment for volume production of precision parts to an accuracy of plus or minus five millionths of an inch (six decimal places).

"But in the aircraft and missile fields, we have practical requirements for seventh-decimal-place accuracy right now," he said. "Projected piloted plane speeds of more than 4500 mph and missile altitudes of up to 240,000 miles with speeds of more than 24,000 mph present incredible precision requirements in making such parts as gyros, control systems, power linkages and various sensing devices," he said.

The Sheffield official said advanced research in such fields as nuclear energy is developing new concepts of measurement complete with new jargon. For example, he cited the estimated weight of an electron as 'one-thirtieth billion, billion, billion billionths of an ounce.

THE ENGINEERING WEEK

IIE Reports Foreign Student Exchange on the Rise

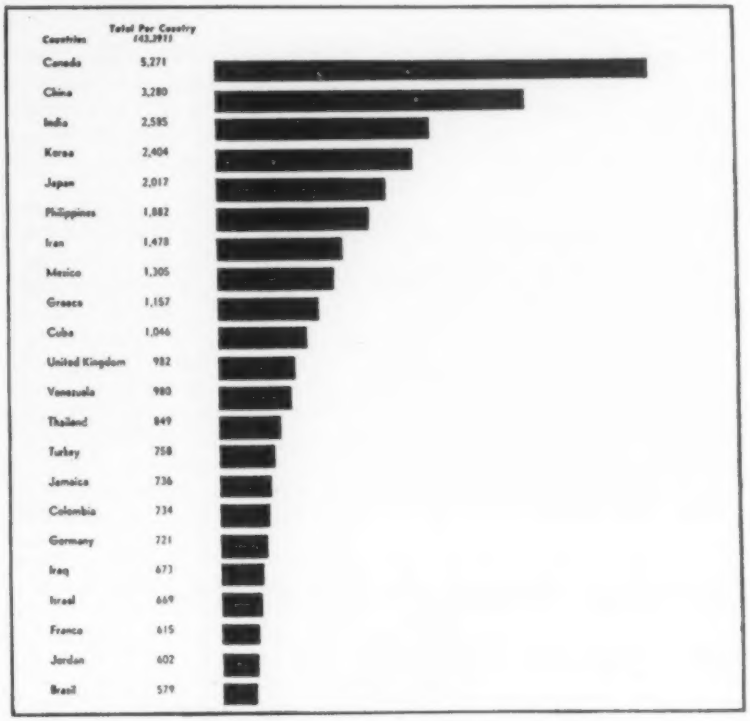
NEW YORK—The greatest number of engineering students ever to take advantage of the educational exchange program conducted by the Institute of International Education was reported in the academic year, 1957-58. Of the 43,391 foreign students in the US during that period, 10,111 majored in engineering; next largest segment, the humanities. An additional 8964 men and women visited the US as teachers and specialists.

A private, nonprofit organization dedicated to developing programs of educational exchange for students, teachers, administrators in 80 nations, the 40-year-old IIE helps locate for employment abroad, promising foreign personnel who were educated or trained in the US under IIE auspices. These people, as well as US citizens with experience in other countries, can be approached by US firms setting up branch offices in foreign countries. The organization selects candidates for 1500 awards, enabling US students to train in over 30 countries.

A kind of administrative clearing house for scholarship funds contributed by various public and private agencies, IIE administers nonacademic programs for 500 American and foreign specialists—men and women in the professions, business, government and the arts. Of value to industrial and educational organizations the world over is the cumulative data file on 60,000 men and women with international study experience.

Of 14,534 US citizens who went abroad under IIE's aegis, 12,845 were students enrolled in foreign schools.

According to figures released by the IIE (see above) 33% of foreign students studying here were from the Far East, 20.9% from Latin America; the remainder from Europe, the Near and Middle East and Canada, in that order. Russia sent only 19 students under the program. Approximately one-half of the foreign students here were undergraduates.



Foreign students in US during academic year 1957-58.

US, USSR Agree on Science Student Exchange

Moscow—Draft agreement on an exchange of American and Soviet scientists in 1959 and 1960 has been signed here by Detlev W. Bronk, president of the US National Academy of Sciences, and Alexander Nesmeyanov, president of the Soviet Academy of Sciences. The draft now is to be considered by the two academies.

It calls for an exchange of scientists to deliver lectures and conduct seminars as well as for a mutual study of research in the two countries. Under its terms, joint research would be carried out, and scientists of the two nations would work together in specific fields for a term of up to one year. The agreement comes under the cultural agreement signed last January.

World Seeks Ways to Store Science Data

WASHINGTON — Approximately 1000 specialists from more than a dozen countries gathered here during the recent week-long International Conference on Scientific Information to hammer away at a common problem—the storage and retrieval of scientific information. The conference was sponsored by the National Academy of Sciences, the National Science Foundation, and the American Documentation Institute.

Discussed were such things as the requirements of scientists for scientific literature and reference services; the function and effectiveness of abstracting an indexing services; the effectiveness of scientific monographs, compendia, review media and specialized information centers for storage and retrieval of scientific information; and the responsibility of governmental bodies and professional societies, for operation of scientific data services.

The conference produced one glaring conclusion: There is virtually no uniformity in collecting and disseminating scientific information. And no agreement on what scientists require in the way of information, nor how it should be presented to them.

Nonetheless, the conference was

rated a success. As one delegate put it, "The real value was in getting such a large group of people together to air their common problems."

Here are some of the more important points brought out at the meeting:

• More study is needed to find out how scientists want information presented, and the kind and amount of information desired. This is considered one of the first steps toward getting an effective scientific information program.

• A need for more personal contacts among scientists. This would be one of the best ways to trade scientific information, yet it is receiving the least amount of attention.

• An objective analysis of the dozens of studies that are being made on the needs and methods of handling scientific information. Such analysis would bring out common denominators in the search to find what scientists need and how they want it.

NATO's Science Committee Agrees on Fellowship Program

WASHINGTON — NATO's Science Committee, which held its first meeting last March, is ready to start on a fellowship program for international exchange of postgraduate students in science.

According to Dr. Norman F. Ramsey, former physics professor at Harvard who heads this committee, there will be about 300 fellowships available for the first year (1959-60) of approximately $3,000 apiece. This figure will vary, however, based on individual needs and the cost of living in the country where the student will study. No country will receive more than 15% of the fellowships.

The fellowship fund, approved for the first year, is $1 million, with every expectation the figure will be raised next year. Sen. Henry M. Jackson (D, Wash.) who heads the Scientific and Technical Committee of NATO's Parliamentarian Conference in Paris this month, recommended the amount be doubled over a 4-year period to total $8 million instead of $4 million.

Applications for fellowships will be received at NATO (Paris) within the next two months. The selection of students from the US to be submitted to NATO for approval will be the responsibility of the National Science Foundation, with advice from the National Academy of Sciences. The fellowship is for only one year, but it is expected that funds will be available for the student to continue his studies until he has completed his course. The fellowship program will be especially beneficial, to countries where there is very little emphasis on science and technology.

ADVANCED STUDY INSTITUTES

A program is underway to encourage the establishment of five or six Advanced Study Institutes, which are summer schools at high academic levels. Funds will be available for approved institutes. Now there are only two—one in France and one in Italy, both concerned basically with Physics. Dr. Ramsey believes that such schools can be of great value in the newer fields of research. Teachers will be experts in the fields, many coming from leading universities for the summer months.

Another program underway is concerned with setting up Joint Research Laboratories. A single cooperative laboratory in some fields could prove most effective, the Committee believes. An example of one in existence is the Cern Research Laboratory in Switzerland for high energy Physics research. Senator Jackson, in his report to the Parliamentarian's NATO Conference, mentions specifically the need for joint projects and centers in basic and applied Metallurgy; upper atmosphere and outer space research; and oceanography. Dr. Ramsey indicated special interest in joint research to solve many problems in oceanography.

Develop Better Air Computer Navigation System

PHOENIX, ARIZ.—An improved navigation system, using low-frequency hyperbolic positioning techniques and featuring a computer-display device for helicopter and other airborne uses, has been developed by Motorola's Defense Systems Laboratory.

Designated PINS, for Position Indication and Navigation System, and sponsored by the Bureau of Ships, the system, like Loran and similar low-frequency hyperbolic navigation systems, gives position information in terms of a simple readout which is related to the hyperbolic lines of position. Unlike Loran, with which it is generic, PINS derives its position information from propagation of continuous waves (CW), using the phase angle difference of two CW signals to determine the fix.

Tested as an airborne navigational aid, the Motorola system takes input information transmitted from the CW stations, automatically computes the phase angle difference, and displays the course and heading to the pilot on a cross-pointer indicator, eliminating special maps, complicated calibration, and unnecessary flight history.

Conventional systems, which make use of a flight log map, often present a distorted picture and carry along errors introduced in the initial adjustment. For the Motorola system, an analog computer with visual display corrects this situation. The computer will be placed in the cockpit and accepts position information directly.

WHAT IT DOES

It computes and stores a Loran-coordinate course to any desired destination from any starting point. As the craft proceeds along its course, deviation and rate of deviation from the predetermined course are computed. These data are displayed on a simple, compact cross pointer, similar to that used for instrument landing system display. This type of display does not interfere with night vision, or cause vertigo—risks associated with chart-board displays.

The computed course is well defined, and bounded to provide a corridor of navigation. It can be quickly and easily changed, even in flight, and a new course computed in seconds. Preliminary flight tests, conducted in a helicopter, have proved the system simple to use and easily understood by a pilot familiar with standard flight instruments, according to Motorola.

COMING EVENTS

DECEMBER

28-30 . . . . History of Science Society, Annual Meeting, DuPont-Plaza Hotel, Washington, D. C.

JANUARY

12-16 . . . . Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

26-29 . . . . American Society of Heating & Air-Conditioning Engineers, 14th International Heating and Air Conditioning Exposition, Convention Hall, Philadelphia.

27-30 . . . . Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York.

28-29 . . . . Armour Research Foundation and American Welding Society, 5th Annual Midwest Welding Conference, Illinois Institute of Technology Campus, Chicago.

FEBRUARY

3-5 . . . . Society of the Plastics Industry, 14th Annual Technical and Management Conference, Edgewater Beach Hotel, Chicago.

6-7 . . . . University of California, 11th Annual Industrial Engineering Institute, Berkeley and Los Angeles campuses.

23-26 . . . . American Society of Mechanical Engineers, Symposium on Thermophysical Properties, Purdue Univ., Lafayette, Ind.

25-26 . . . . US Atomic Energy Commission and Kansas State College, Midwest Industrial Radioisotopes Conference, Kansas State College, Manhattan, Kansas.

MARCH

3-5 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco.

8-11 . . . . American Society of Mechanical Engineers, Gas Turbine Div., Engineering Conference and Exhibit, Netherlands-Hilton, Cincinnati, Ohio.

9-12 . . . . American Society of Mechanical Engineers, Aviation Conference, Statler-Hilton, Los Angeles.

16-18 . . . . Society of Automotive Engineers, National Passenger Car, Body and Materials Meeting, The Sheraton-Cadillac, Detroit, Mich.

16-20 . . . . American Society for Metals, 11th Western Metals Exposition, Pan Pacific Auditorium, Los Angeles.

Old blade, new twist . . .
Mixed-flow impeller reduces noise levels by 6 db and 10 db respectively on the evaporator and condenser sides of a ¾-hp room air conditioner, compared with propeller fans previously used in the same appliance. Developed by Torrington Manufacturing Co's Air Impeller Div Engrg Dept, the blade shapes are specially contoured—changing from a propeller shape at the intake edge to a centrifugal fin shape at the discharge end. Torrington reports that fan motor load was reduced from 1/10 hp to 1/25 hp for the same air-flow output. (See P.E., Jan. 5 Design Issue on Mixed-Flow Impellers.)

See More External Use of Plastics on Cars

CHICAGO—"European auto companies are taking to plastics at a greater rate than are US car makers," said H. E. Humphreys, Jr, chairman of US Rubber Co, at the National Plastics Exposition here "partly because they can use plastics economically on a lower production base, and also partly because they are willing to take a chance." He added that US auto makers are nevertheless experimenting with plastics for off-year styling changes, but not in any great amount.

Humphrey guessed that Cadillac has used polyester glass laminates for experimental exterior parts such as a trunk lid. He also said that the trend toward the smaller car in the US could mean less use of plastics, since cutting down interior trim is one means of reducing over-all cost and getting closer to the basic shell.

Asked what he thought was holding up greater use of air spring suspension for autos, Humphrey said that "cost" seemed to be the greatest obstacle. He seemed confident that air suspension would be adopted ultimately on a subtantial basis.

Another US Rubber spokesman said the company had done some experimental work with asbestos as a reinforcing agent, but that so far it had proved more expensive than glass for the strength that it provided.

A rumor at the show persisted that Chevrolet and Fisher Body are now testing three fiberglass inboard motor boats, styled somewhat along the lines of the 1959 Chevy, and to be sold by Chevy dealers.

Not the Wheel– the Nut Behind It

DETROIT—The nation's traffic toll can be reduced by a balanced program for improving drivers, roads and autos rather than by critical attacks on vehicle design alone, according to Charles A. Chayne, General Motors

vice-president in charge of engineering.

The auto is only one of three elements involved in traffic accidents, he said. The driver and the road are the other two. Educational and engineering efforts toward safety improvements should include all three, he urged.

He suggested simplified driver controls that "will enable drivers to concentrate still more on watching road and traffic conditions"—such as GM's experiments with "single stick" steering, accelerating and braking control. But these will be driver aids, rather than automatic electronic or mechanical substitutes for drivers.

He also urged more cooperative research between auto and road engineers to develop electronic or electrical systems that communicate information to the driver from the highway.

We Get Translations as Fast as Russians

NEW YORK—Despite stories to the contrary, US engineers can get up-to-date technical information as quickly and as easily as their Russian counterparts, according to Ralph H. Phelps, director of the Engineering Societies Library of New York. Mr. Phelps spoke last week at ASME meeting.

He said that if the Russians have profited more than we have from the technical literature, they have worked harder at using it. Soviet abstracts have no subject indexes and are difficult to use, he said. Phelps also was firm in stating that none of the abstracting services are "years behind," as was stated by a witness at a Senate committee hearing. Phelps said that many literature searches cost from under $100 to less than $1000, not from $1000 to $100,000 as the witness stated.

Mr. Phelps said that although there is no quick, easy solution to difficulties imposed by the increasing flood of technical literature, the indexing and searching services are far from choked by it.

In another technical session, W. L. Starkey, of Ohio State Univ, and H. A. Cress of Battelle Memorial Institute, presented a paper which disproved the popular theory that the primary cause of failure in a wire rope is the result of tensile stress. They showed that by far the greatest stress in a wire rope results from Hertz contact stresses at points of wire-on-wire contact, and that the usual mode of failure in wire rope is fretting-fatigue.

READER TO EDITOR

Why Engineers Retard Invention

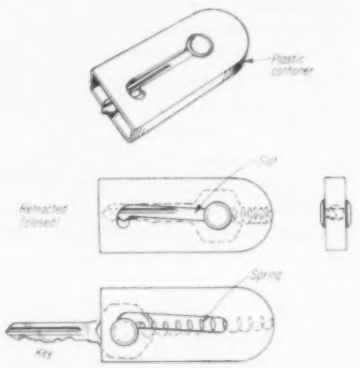
To the Editor:

PRODUCT ENGINEERING has printed several articles, by men of experience, on inventions (July 28, p 26; Sept 22, p 38; Nov 3, p 24). You have done an excellent service in pointing out the various conditions that exist, but, who will do anything to correct such conditions? The reporters? The engineers? Not likely! As you report, management should not rely solely on its engineers to appraise new ideas. Why? It may help to point out that engineers are affected by their emotions much more than is realized. They are also more prejudiced than is realized. Of course, not all engineers fit the following, but 38 years' experience in presenting ideas and inventions to them suggests they think along these lines:

1. The inventor has no degree or education.
2. The inventor is a technician, farmer, or a machinist, so what can he know?
3. The invention is what the engineers could have thought of but didn't (it is that simple). It "hurts" him to tell management that it is a good idea.
4. Company policy may make it necessary for engineers to ask the inventor to sign a nonconfidential agreement. This allows the engineers to come up with a different design that may be patentable, and no royalty need be paid. Engineers love to do such a thing just to prove they are engineers and gratify their egos, even if the inventor is an engineer.
5. Based on the fallacy that one has to be "educated" to invent, engineers think they are inventors. The engineers can make design changes, once the basic idea of the inventor is clear to them; and the patent laws are such that a passable new "invention" is available to the company, excluding the real inventor.
6. The engineer is safer in pointing out why the idea wont' work, than if he sticks his neck out to boost it. He gets no reward in boosting it, and possibly extra work. He is interested in security of job, salary, promotion, etc. All his education has caused him to be cautious. The inventor uses intuition that he was born with, whereas education stifles this intuition with excess tuition.
7. It is easier and safer to tell the inventor "No" in many words, than "Yes" in a few words. Actually, most engineers are not looking for new ideas from anyone else. Yet, management wants and needs new inventions. What needs to be recognized by management is the fact that invention requires a very *different* type of mind than does engineering. Actually, the types of mind are nearly opposite in many ways. Therefore, the proper consideration of inventions needs a mind entirely *different from either*, and chiefly concerned with markets, profits, possibilities and scope from a business standpoint. To give the engineers their just credit, when management says "Make this work efficiently," they will do it. The "this" however, often is something that other engineers have said could not work.

A further help to all concerned would be recognition by management that the legal provisions—that inventors have 17 years of reward—be ethically and honorably adhered to for the greater stimulation of inventors. Less snobbery on the part of engineers, and more understanding of the process of invention would help. Time, money and education make an engineer; but the inventor is born with ability to visualize and imagine.

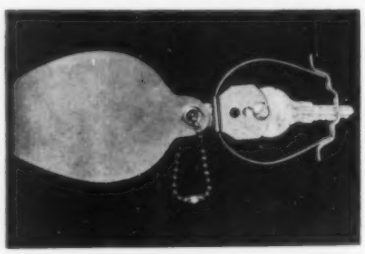
—W E GREENE
Los Angeles



Self-retracting Ignition Key

To the Editor:

In your "Why Don't They . . ." (Oct 20, p 38) I was interested in the request for a self-retracting ignition key. How's this? The key jumps out of ignition slot when turned off. I developed the thing some eight years ago, had it searched, hand-made a dozen samples . . . and no one was interested. —LOUIS KOPITO
Baird Atomic Inc
Cambridge, Mass.

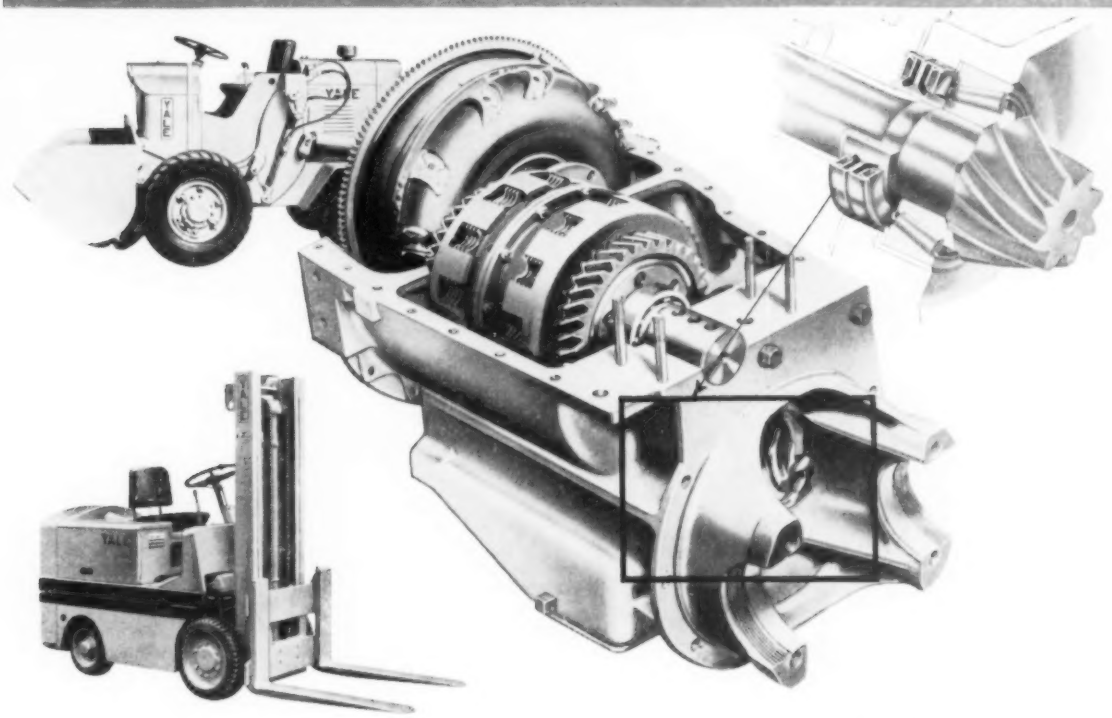


To the Editor:

I have invented a device to prevent car thefts, locked-out drivers and accidental startings by children, plus uses for your housedoor, tool cribs, poison cabinets, etc. I call it KEY-POP.

Patent was applied for in 1956 and most of my claims have been granted. The patent should be issued within the next couple of months. A manufacturer has been found and the distributor will be C. J. Allina Assoc., 110 Washington St, New York City. It will be available in about four months. —H H FURN
White Plains, N. Y.

NATIONAL OIL SEAL LOGBOOK



Oil seals "back-to-back" in torque transmission of Yale industrial tractor shovels

In both their new industrial tractor shovels and the famous KGA51 series lift trucks, Yale and Towne employ National Seals to separate transmission oil from differential lubricant. The seals are used at the pinion position of the unique, fully automatic Yale Torque Transmission. This assembly is basically a combination of a torque converter and a constant mesh transmission eliminating gear shifting.

Pinion sealing almost always presents unique demands on oil seals; performance must be of the highest order since most pinion seals are difficult to reach for replacement after assembly, and repairs to adjoining assemblies are costly.

To assure long-term, trouble-free performance for their customers, Yale and Towne install two 50,000 series National Seals at the pinion position. The seals are mounted back to back, one with its lip facing and retaining transmission oil; the other with its lip facing and retaining differential lubricant. Both seals used are standard-design National Micro-Torc leather seals with precision-made tension springs insuring optimum seating of lip on shaft.

National offers over 2,500 different standard-design oil seals — leather, synthetic rubber or felt. National Seal engineers are at your service—they're listed under Oil Seals in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

CIRCLE 128 READER SERVICE CARD

Micro-Torc*— National's "break-through" in leather seals

Micro-Torc Oil Seals, developed by and made only by National, have established new performance standards for leather seals. They absorb less power, run cooler and last longer than any leather seal made. Properly employed, they have *no measurable leakage* throughout service life.

Micro-Torc Oil Seals are produced by *coating*—not impregnating—chrome retanned leather with a dry lubricant in an elastomer binder. The result is a mechanically stable sealing member which does not leak oil *through* the leather, but does permit the unimpregnated central part of the leather to absorb oil for periods of momentary lubricant starvation.

See, feel the difference!

Micro-Torc sealing lips actually *look* and *feel* slicker, smoother — their cool-running, high-lubricity coating is plainly apparent to the touch. Ask your National Seal engineer to let you *feel the difference!*

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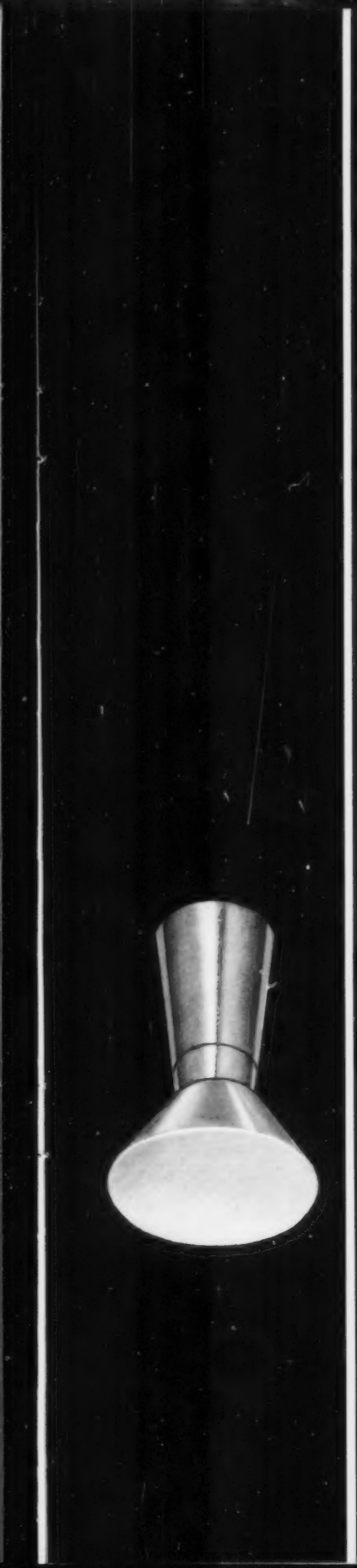
What
the
designer
conceives...
aluminum
achieves!



Aluminum screw machine knobs — economical and versatile for your high quality products — offer designers infinite control panel styling possibilities both for shape and for color.

In finished shapes such as the examples shown, aluminum gives sharp, clean lines . . . unusually fine "as machined" finish . . . plus the quality feel of solid metal. Low tooling cost, particularly as compared to die casting or stamping dies, adds not only initial economy but model-change versatility as well.

And for the brilliant beauty of any color, these knobs take permanent finish by one-step anodizing — usually at far less cost than chrome plating or similar plated surfaces. Aluminum offers still more useful properties, such as light weight with high strength, corrosion resistance, non-sparking and non-magnetic qualities.

If you would like design details for the parts shown here, complete with cost and production data, please send in the coupon below.

(Kaiser Aluminum does not manufacture screw machine parts, but does offer technical assistance to parts suppliers throughout the country. Contact your local screw machine products manufacturer for further information and quotations on specific parts in aluminum.)

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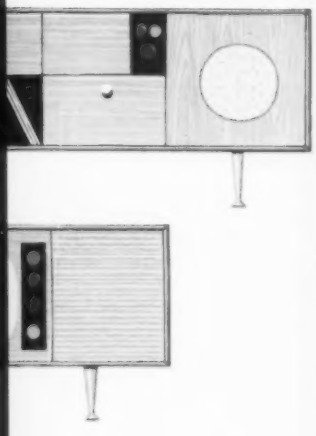

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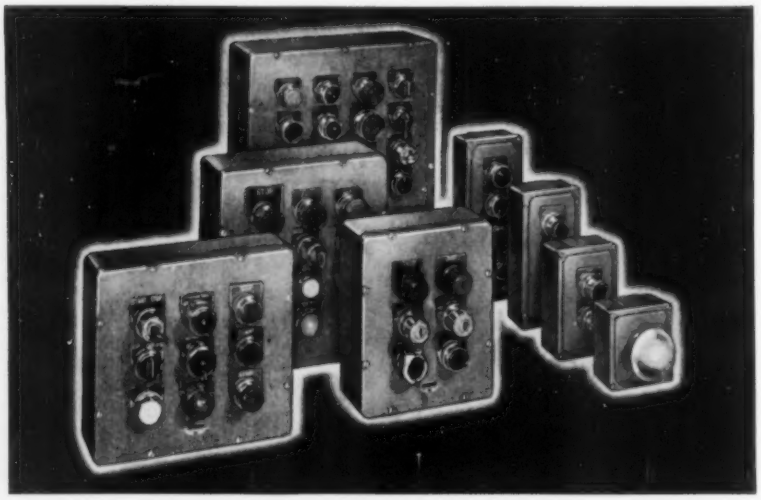


NEW OIL-TIGHT CONTROL STATIONS PERMIT BASE OR COVER MOUNTING OF CONTROL UNITS

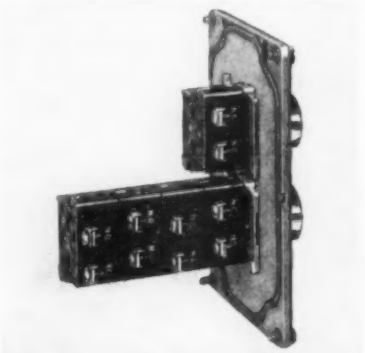
To meet the growing demand for greater flexibility in the assembly of oil-tight control stations, Cutler-Hammer developed a new line of precision die-cast enclosures. These new Cutler-Hammer Control Stations are unique in the fact that they will accommodate either cover or base mounted control units with equal facility. Many have shown a preference for these new control stations because a base mounted pushbutton, indicating light, etc. eliminates the necessity for hinged wiring.

One to Sixteen Unit Control Stations

Matching Cutler-Hammer Oil-Tight Control Stations are available in eight sizes, the largest will hold sixteen control units. The hinged covers on the six, nine, twelve, and sixteen unit enclosures are snap removable for added working-room during assembly and alterations. The one to four unit enclosures are available in either the normal depth or exclusive shallow depth for use where space limitations are critical. The shallow depth enclosure is only 2⅜" deep and will accommodate one double contact block for each control unit. All normal depth enclosures, including sizes six and nine, permit a maximum of four circuits per control unit; while the twelve and sixteen unit enclosure provides six circuits per control unit.

Oil-Tight Cavity Mounting Cover Plates

Cutler-Hammer also has available a complete line of oil-tight cover plates for cavity mounted control stations. Machine designers and panelbuilders have shown a marked preference for Cutler-Hammer Oil-Tight Control

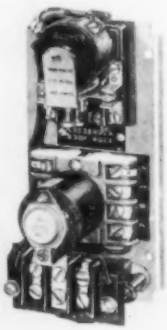


Units for cavity mounting because one double circuit contact block takes 40% less space behind the panel than the next smaller unit. Also additional contact blocks are easily tandem mounted providing as many as eight separate circuits in any combination of normally open or normally closed contacts.

C-H Master Design

For further information about these versatile oil-tight control stations and heavy-duty pushbuttons and control units, write today on your company letterhead for the illustrated booklet, EL178-Y-249. C-H Master Design.
Cutler-Hammer Inc.,
Milwaukee 1, Wisconsin.

NEW TRANSISTORIZED RELAY COMBINES FINE-SENSITIVITY WITH HEAVY-DUTY CONSTRUCTION



Many panelbuilders have found this new Cutler-Hammer Transistorized Relay to be particularly useful whenever their control problems call for an A-c relay which will respond to either an A-c or D-c signal between .0028 and .025 amperes. The heart of this compact relay is the plug-in type signal amplifying module which contains all the electronic parts. This tough module is practically indestructible, and the plug-in design insures rapid maintenance . . . cuts downtime to a minimum. The Bulletin 13535 transistorized relay requires no warm up time and it is exceptionally quick in operation. 600 volt model offers a wide selection of contact arrangements . . . rated 15 amperes. 110 volt model rated 10 amperes. Prices unusually low. Cutler-Hammer also offers conductive liquid level probes, and photo-cell units for use with the transistorized relay. For further information, write today for Bulletin 13535-Y-249.

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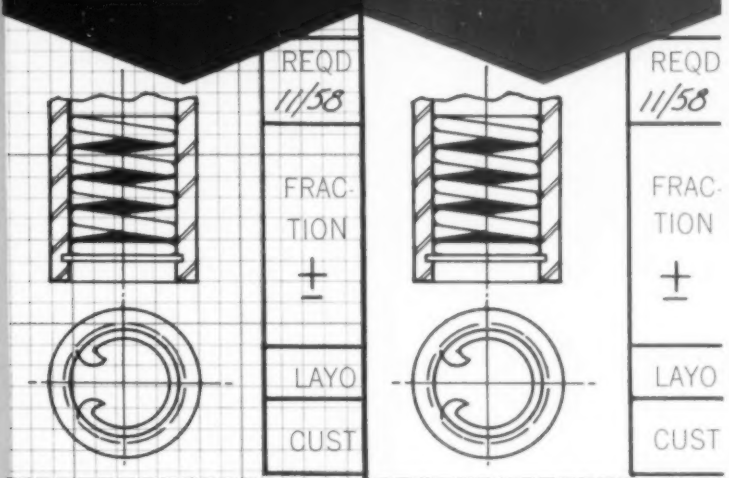

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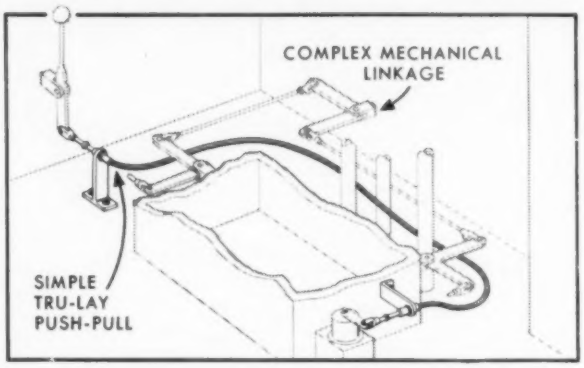
Tru-Lay Push-Pull controls provide positive remote action over long or short distances. Because they operate while flexing, they can snake around obstructions. They are ruggedly constructed, easily installed and operated, and are sealed against dirt and moisture. Push-Pulls are simple, have but one moving part, are noiseless, and give a lifetime of accuracy. Linkages, on the other hand, are complex. They're made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.



Here's Why Push-Pull Controls Simplify Design, Give Better Performance

Long Life—We have never heard of a Tru-Lay Push-Pull wearing out in normal service.

Dependable Operation—Top performance under the most adverse conditions... in temperatures ranging from −70°F to the high levels of jet engine operation... in wet locations... in abrasive atmospheres.

Freedom from Trouble—Inner working member is fully protected by tough, flexible conduit... lifetime factory lubrication... sealed against entrance of dirt, moisture, and other foreign matter... cold swaging of all fittings.

Accuracy—Built to the most exact standards of quality and precision. On automobile pushbutton transmissions, for instance, Push-Pull controls provide five positions with a total movement of only .560".

Capacity—Push-Pull controls will handle jobs with as much as 1,000 lbs. input, 150 feet or more from the control point.

Adaptability—Push-Pull controls can be adapted to countless applications. Standard anchorages, fittings, and heads meet almost any requirement, and modifications can be made to fit special situations.

Design Engineers Report on Benefits

Saves Time, Labor, and Material
"We use Push-Pulls to operate clutch controls on the main power unit, feed conveyors, and delivery conveyors... and we save the time, labor, and material required for planning and engineering the old linkages."

Greater Flexibility of Design
"Push-Pulls give us flexibility in locating the hydraulic control valve in relation to the operator's position."

Cost Less to Install
"They are easier and less expensive to install than linkages for remote control of power take-off."

Solution to Tough Problem
"Can be installed where straight rods are impossible."

Eliminates Maintenance
"No maintenance whatsoever; not even lubrication is required."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods, and other lost-motion devices for remote control of hydraulic valves."

Provide Accurate Control
"We get minimum backlash because the cable is designed to close tolerances with minimum drag and lost motion."

Push-Pulls Can Help Solve YOUR Remote Control Problems

Push-Pull controls are solid as a rod and flexible as a wire rope. You can use them in the electrical, hydraulic, and pneumatic systems on construction equipment, on farm implements... almost *anywhere* convenient remote control is desired. For complete details on how you can use them, write for a copy of the Push-Pull Data File. It contains 7 bulletins which describe in detail the operation of Push-Pulls, their applications, features, and advantages. Our engineers will be glad to help you make Tru-Lay Push-Pull controls a part of your product.

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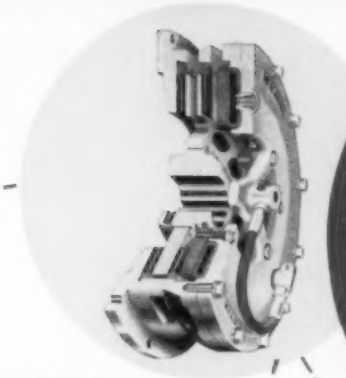
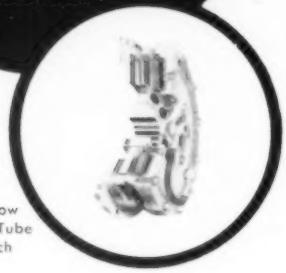


"Wichita Clutches are highly **DEPENDABLE** *on our automatic winders,"*

SAYS
LAWRENCE W. EGAN
OF
FRANK W. EGAN & CO.

Egan uses a Wichita Air Clutch on each of the winding spindles of this rugged, three spindle turret winder. It is one of twelve units recently designed and built by Frank W. Egan & Company of Somerville, New Jersey, for a large converter. A simple cam arrangement automatically engages the new core and disengages the full roll as the turret is rotated into transfer position.



Wichita Low Inertia Air-Tube Disc Clutch

These Wichita-equipped winders are designed to handle a wide range of webs.

"Since our winders are designed to accommodate various webs," says Mr. Egan, "we require a highly dependable clutch which can be maintained easily and does not involve complex linkages to obtain necessary automatic features. The design of the Wichita Clutch also lends itself to a more compact assembly."

If you want the best service from your equipment, be sure it is equipped with Wichita Air Clutches and Brakes.

Contact your nearest Wichita Engineer!

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L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn., Philadelphia 44, Pa., and New York, N. Y.
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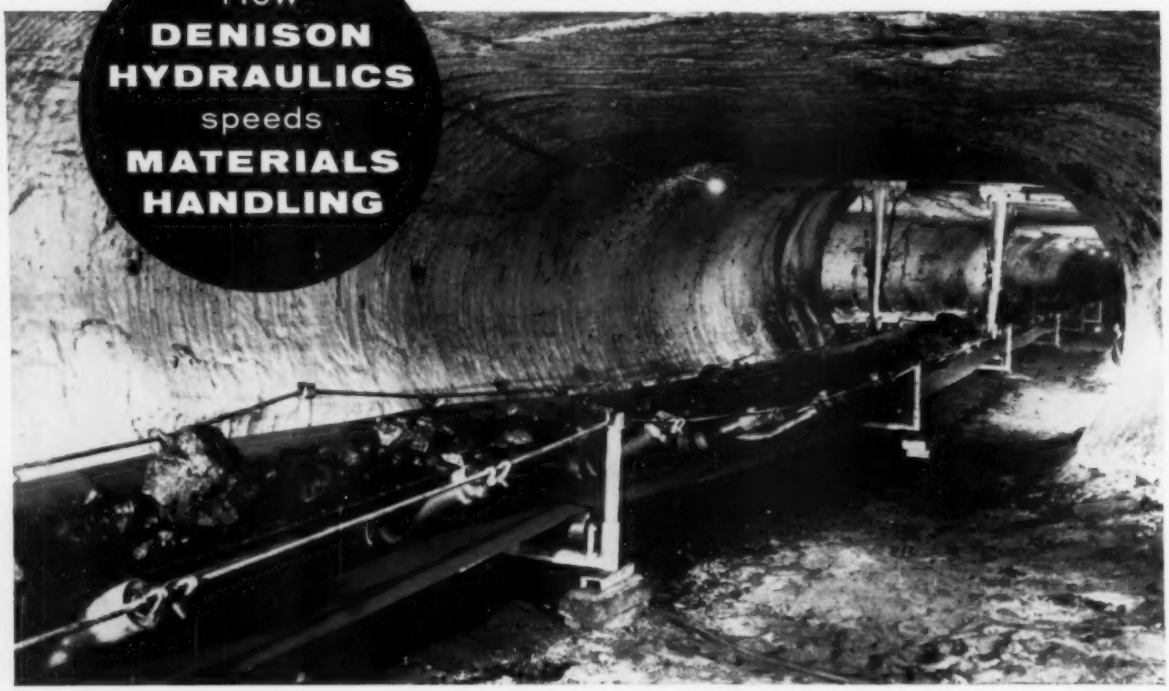
WICHITA FALLS, TEXAS, U.S.A.

CIRCLE 133 READER SERVICE CARD

How **DENISON HYDRAULICS** speeds **MATERIALS HANDLING**

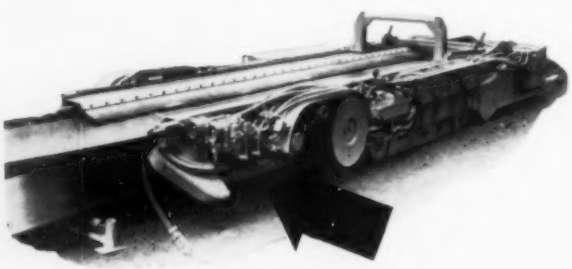
BELT-LOADS OF COAL FLOW SMOOTHLY *on Goodman "Ropex" conveyor applying new design concept which supports loaded belt on chain-linked suspended idlers. Denison hydraulic power drives the "Ropex" efficiently at low cost.*



Here's how the **GOODMAN** "Ropex" conveyor rolls vibration-free on **DENISON** hydraulic power

Faced with the problem of designing drives and controls for coal mining machines that would give smooth, flexible, vibration-free power—Goodman Manufacturing Company found the answer . . . a Denison hydraulic transmission system.

In developing the "Ropex"—an extensible belt-supported conveyor—Goodman designers incorporated four rugged Denison Axial Piston Pumps, four Fluid Motors and relief valves.



"ROPEX" SELF-PROPELLED CONVEYOR *developed by Goodman Manufacturing Co., Chicago, incorporates 4 Denison Axial Piston Pumps, 4 Fluid Motors and relief valves in its smooth, hydraulic transmission. Shown above, "Ropex" tail section with position of Denison hydraulic motor and valves indicated.*

The "Ropex" consists of two basic sections: The *head end section* discharges on the secondary belt and holds 100 feet of belt storage . . . paying in and out as the tail end moves. The *tail end section* stores 650 feet of wire rope (which supports belt rollers) on each rope drum. Ropes are kept tight, when winding or unwinding, by two hydraulic motors.

In the tail end, two Denison Fluid Motors operate the tractor treads—and are controlled by two Denison Pumps for low-speed tramming or moving backward and forward. Two other Denison Fluid Motors independently drive gearing of the rope drums. For high-speed moving from place to place, the two pumps which furnish power for the ropes are diverted to supply power for the treads.

Result: a compact "Ropex" unit that cuts moving costs . . . increases load-carrying ability with minimum spillage . . . assures continuous trouble-free operation . . . ease of control.

It's another efficient job done by Denison hydraulic power—the kind of job your Denison hydraulic specialist can help *you* do. Write Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.

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DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

J&L STAINLESS STEEL

BAR • WIRE • SHEET • STRIP

ANNOUNCING

the Newest Source of Quality Stainless Sheet and Strip in the Industry

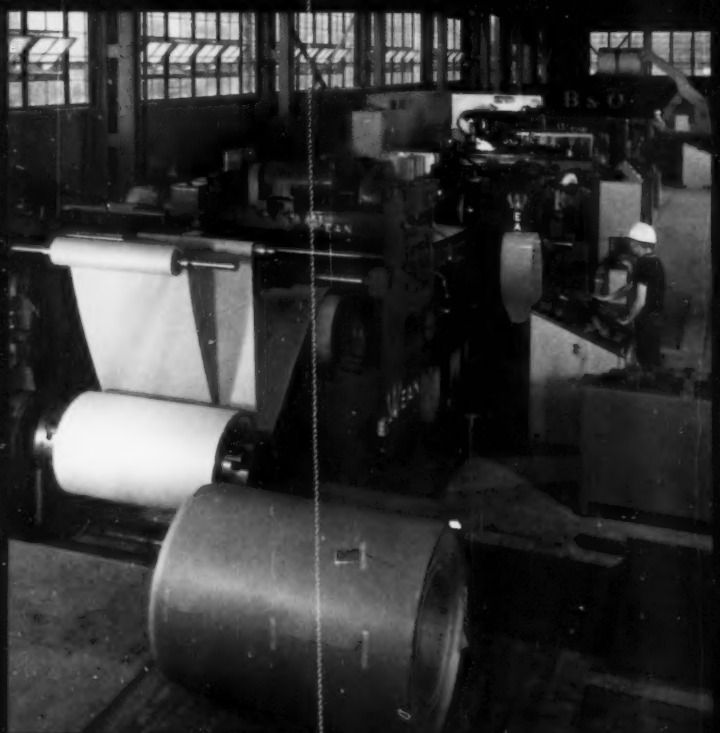
J&L's Completely New Stainless Mill . . .

designed and engineered to give you the fastest delivery on Quality Stainless Sheet and Strip

Now you can demand the quality you need and get the service you want from the most advanced stainless steel sheet and strip source in the industry. J & L's new Sendzimir Mill at Louisville, Ohio, is the result of years of planning by specialists to provide a new facility of such perfection that yield of the highest quality is assured.

J & L can now offer stainless sheet and strip to the most exacting specifications, producing stainless sheets to extremely close tolerances in widths up to 48 inches.

By efficient, flexible scheduling and adequate inventory support, J & L offers stainless steel buyers everywhere the fastest possible service.



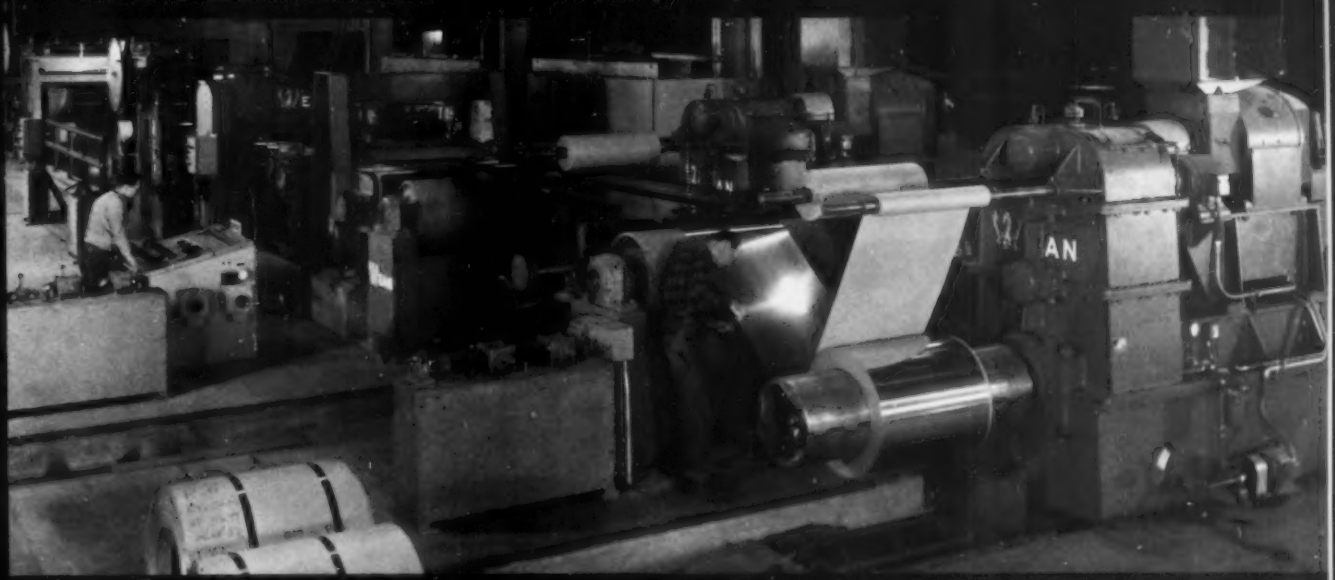
▲ Coil Preparation Line for Incoming Hot Rolled Sheet

▲ The 54" Temper Mill

▼ Hot Anneal Furnace—Entry End

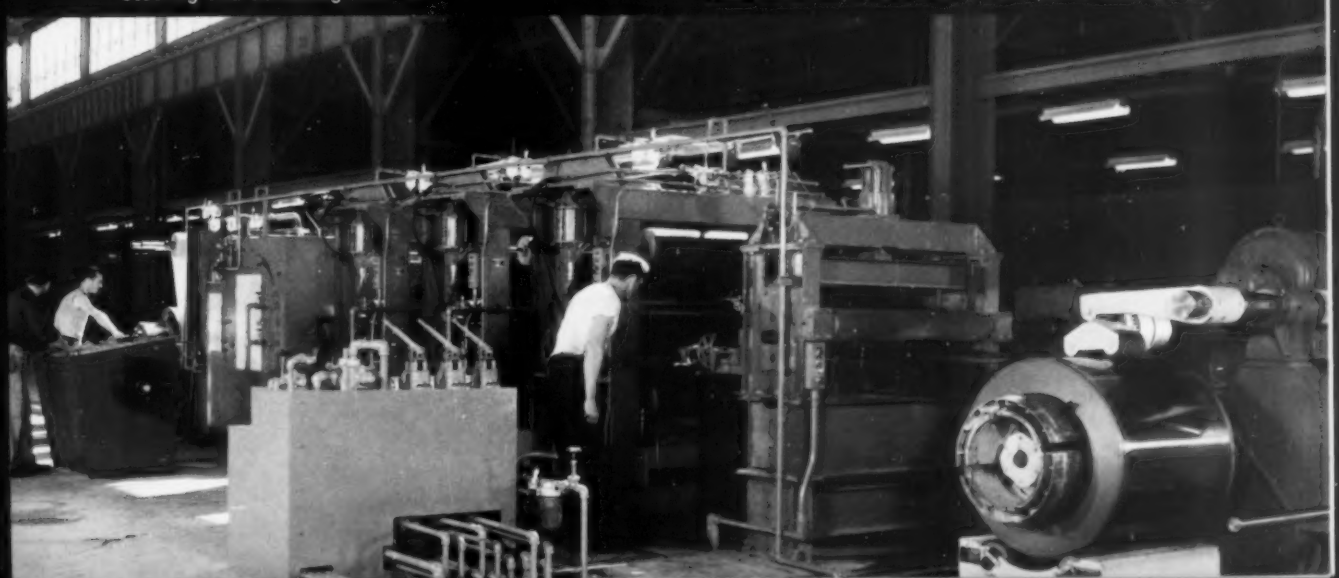
▲ The Sendzimir Mill

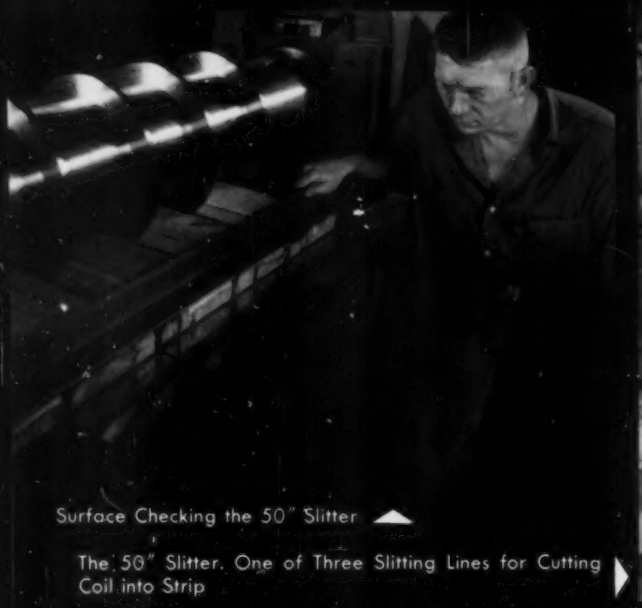
Interior View of the Intricate Mechanism of the Sendzimir Mill ▶

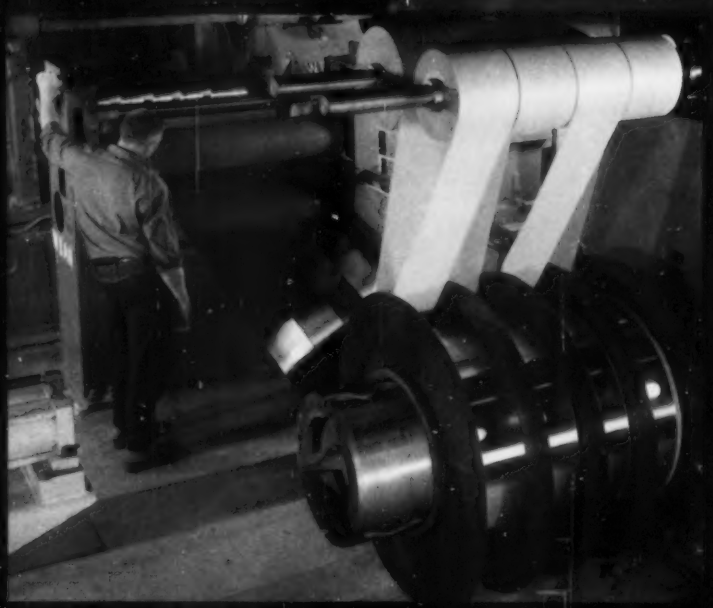


Scouring and Scrubbing Line ▼

▲ Cold Roll Anneal and Pickle Line—Discharge End



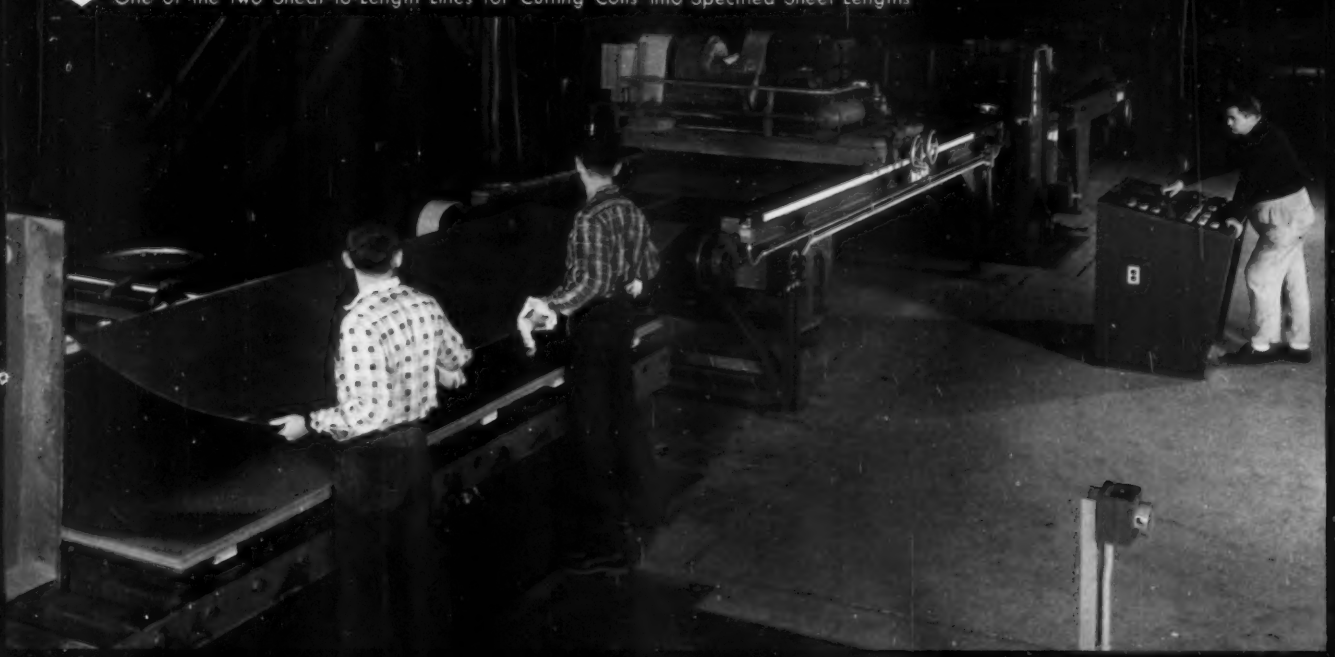




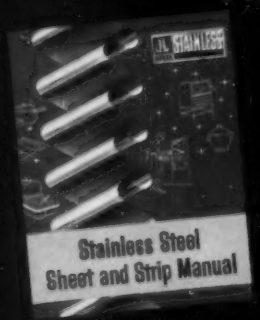
Surface Checking the 50" Slitter ▲

The 50" Slitter. One of Three Slitting Lines for Cutting Coil into Strip ▶

▼ One of the two Shear-to-Length Lines for Cutting Coils into Specified Sheet Lengths



STAINLESS and STRIP DIVISION DISTRICT SALES OFFICES



Write for your copy of the J & L Stainless Steel Sheet and Strip Manual today.

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Los Angeles 5, California

CLEVELAND
The B. F. Keith Building
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Cleveland 15, Ohio

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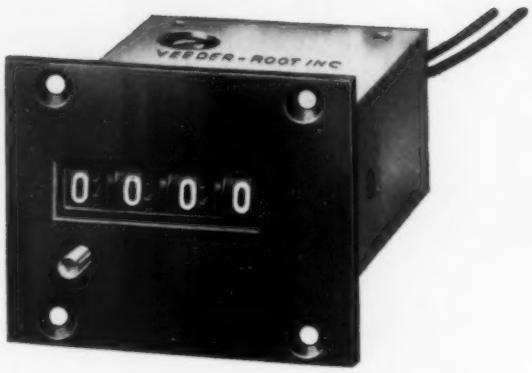
J&L STEEL STAINLESS
BAR • WIRE • SHEET • STRIP

Jones & Laughlin Steel Corporation · **STAINLESS and STRIP DIVISION** · **Box 4606, Detroit 34**

LITHO USA



You told us to "tell all" about this ALL-NEW PANEL-MOUNTED HIGH SPEED ELECTRICAL COUNTER

You asked for it! Hundreds of requests for "complete specs" rolled in on the announcement of the 1591. So here they are . . . all on one sheet . . . for your counter file. And here's a quick review of the most newsworthy features of this all-new counter:

- Instant electric resetting.
- Push-button reset, either mechanically on the machine, or electrically from a distance.
- One button resets an entire panel.
- Panels can go right in your office.
- Counter is small, but figures are large.
- Speeds rated to 3,000 counts per minute.

ORDER NOW!

EVERYONE CAN COUNT ON

Veeder-Root

INCORPORATED

Hartford 2, Connecticut

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Offices and Agents in Principal Cities

For Your COUNTROL FILE

Complete Specifications ...Series 1591 Counter

•

Overall Dimensions: 2.1" wide, 1.7" high, 2.6" deep. Shipping weight approximately 1 lb.

Method of Counting: Actuated through electromagnets, these counters can be connected in series with any device having a contact arrangement. For optimum operation, 60% contact time is necessary.

Reset: Manual or electrical. Manual reset is accomplished by depressing the reset button extending through the front panel. Electrical reset is accomplished by energizing the resetting coil momentarily.

Size of Figures: .188" high.

Color of Figures: White on black.

Number of Figures: 4 or 6.

Speed: 3000 counts per minute is the maximum recommended.

Watt Consumption: Operating coil — 6 watts; reset coil — 15 watts.

Operating Voltage: 6, 12, 24, 48 & 115 volts DC are standard. For operation on AC power, suitable electrical components must be added externally to the counter.

Reset Voltage: 6, 12, 24, 48 & 115 volts DC are standard.

Voltage Variation Permissible: 10%, but not more than 10 volts.

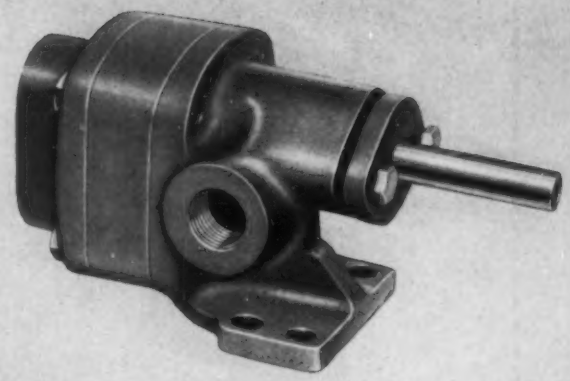
Temperature Rise: 140°F under normal operating conditions when coils are left energized for long periods of time.

Lubrication: After every 30-million counts, lubricate per Veeder-Root service instructions V-78116-1.

Finish: Die-cast frame, with aluminum covers. Panel Plate dull instrument black.

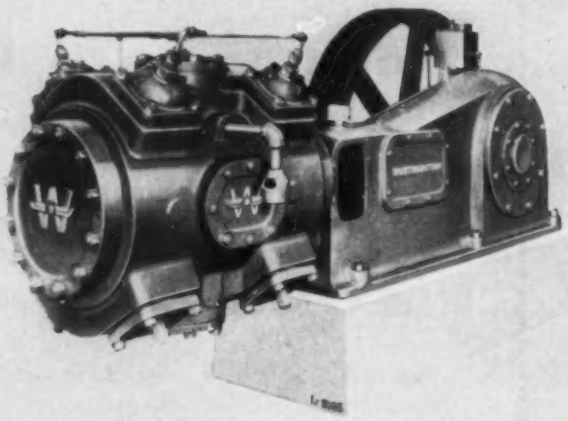
NOTE: Any change in any of these Standard Specifications (above) makes the counter a Non-Standard item, produced to order only.

Monobloc Rotary Pump



Rotary Pump

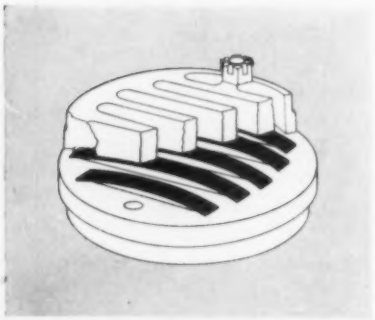
Monobloc Centrifugal Pump



Water-cooled Compressor

On any pump or compressor you choose, only Worthington gives you these

EXCLUSIVE

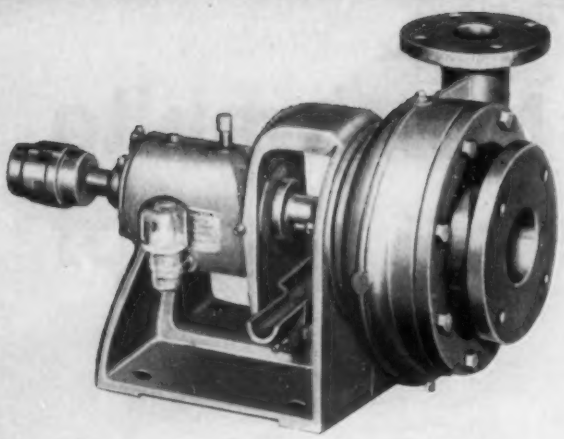


Feather Valve Lightest, fastest-acting compressor valve available. Works with no impact, is all but indestructible, and has an amazing record of long life with negligible maintenance costs.

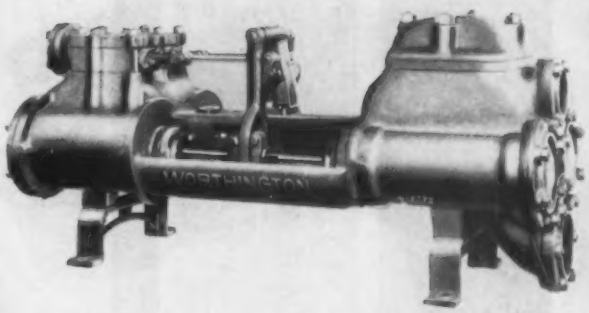
70,480 Combinations Completely standard and interchangeable components let you save up to 50% on spare parts inventory, permit you to design and build over 70 thousand "special" pumps using but 6 SESC pumps.

Monobloc Rotary Pump Eliminate alignment problems, simplify layouts by choosing up to 28 different ways to hook up pump piping. Saves you time, materials, is less expensive than separate pump, motor and baseplate.

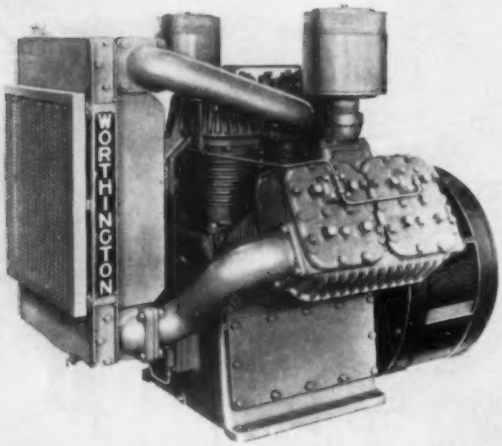
CIRCLE 137 READER SERVICE CARD



Chemical Centrifugal Pump



Steam Pump



Radial Air-cooled Compressor

Balanced Angle Air-cooled Compressor

DESIGN ADVANTAGES

Designing and manufacturing outstanding products has been a success story typical of Worthington for 118 years. Foremost examples of this leadership and engineering skill are the exclusive design advantages of Worthington pumps and compressors. Three of the most important are illustrated at left: Feather Valves*, Monobloc Rotary pumps, and the unmatched flexibility achieved through standardization of the SESC (Standard End Suction Centrifugal) line.

Worthite*, Worthington's *super* stainless steel, has set new corrosion resistance standards for chemical pumps. Worthington air-cooled or water-cooled compressors include carefully balanced operating parts, low piston speeds, and liberal cooling surfaces on cylinders and intercoolers or aftercoolers. Increased performance and accessibility of portable and balanced angle compressors and the money-saving benefits of easy installation and low maintenance of the entire pump and compressor line lend further testimony to Worthington engineering competence. But whatever your application, your design problem, Worthington can help you.

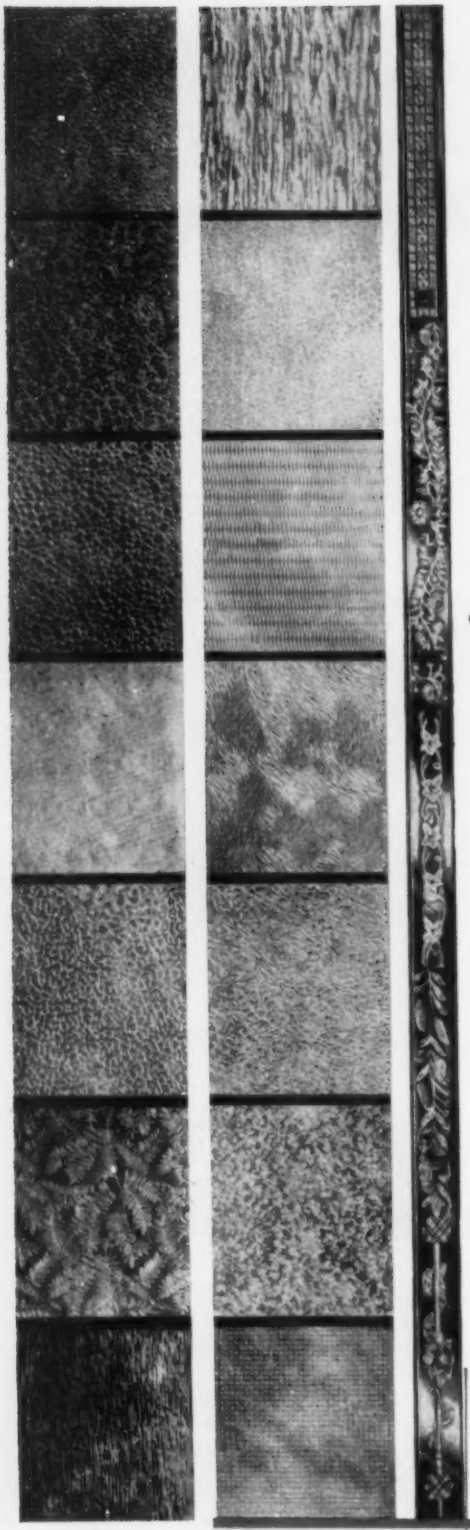
Your nearby Worthington representative stands ready to explain the many advantages of one *complete* Worthington pump and compressor line to you. For more information on how to improve your product's performance or reduce engineering design and expense, contact him now. Or write for bulletin, Worthington Corporation, Section 104-7, Harrison, N.J. In Canada, Worthington, Ltd., Brantford, Ontario.

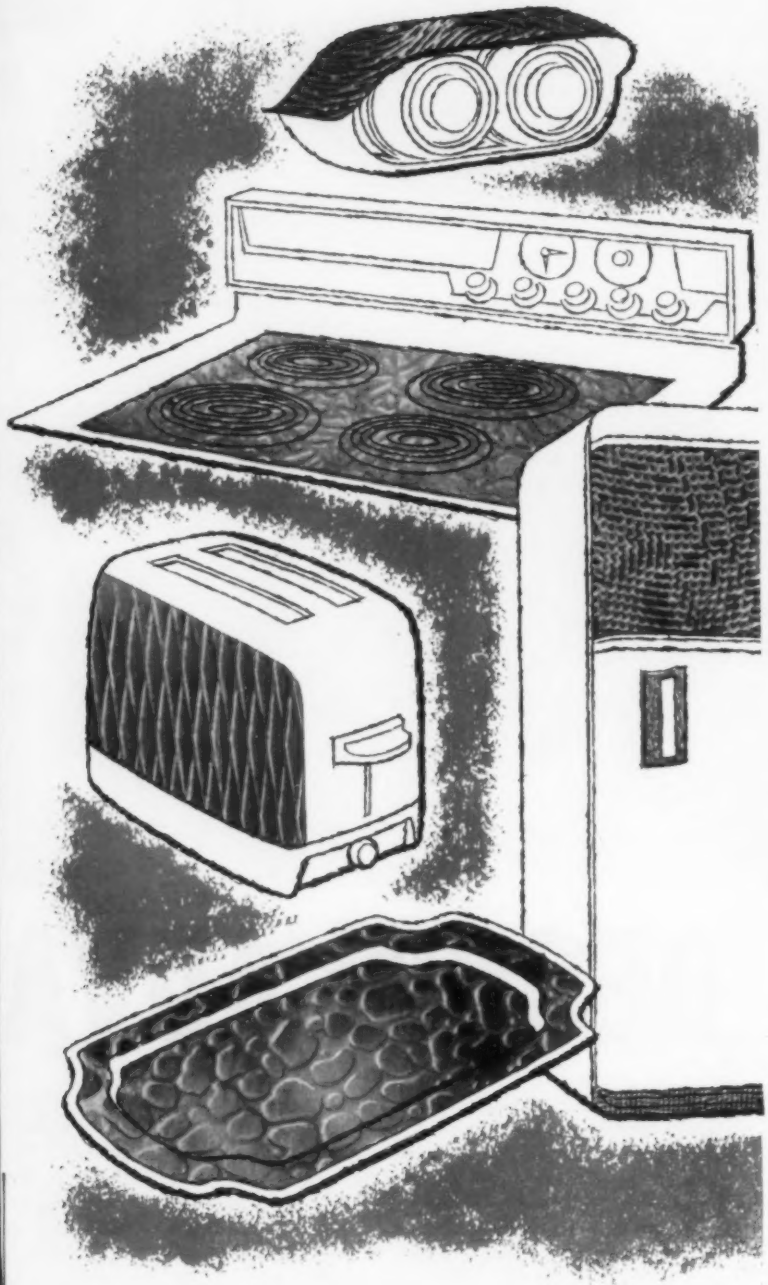
WORTHINGTON

*A high-nickel, high-chromium, low-carbon alloy steel. Trademark Reg. U.S. Pat. Off.

CIRCLE 138 READER SERVICE CARD

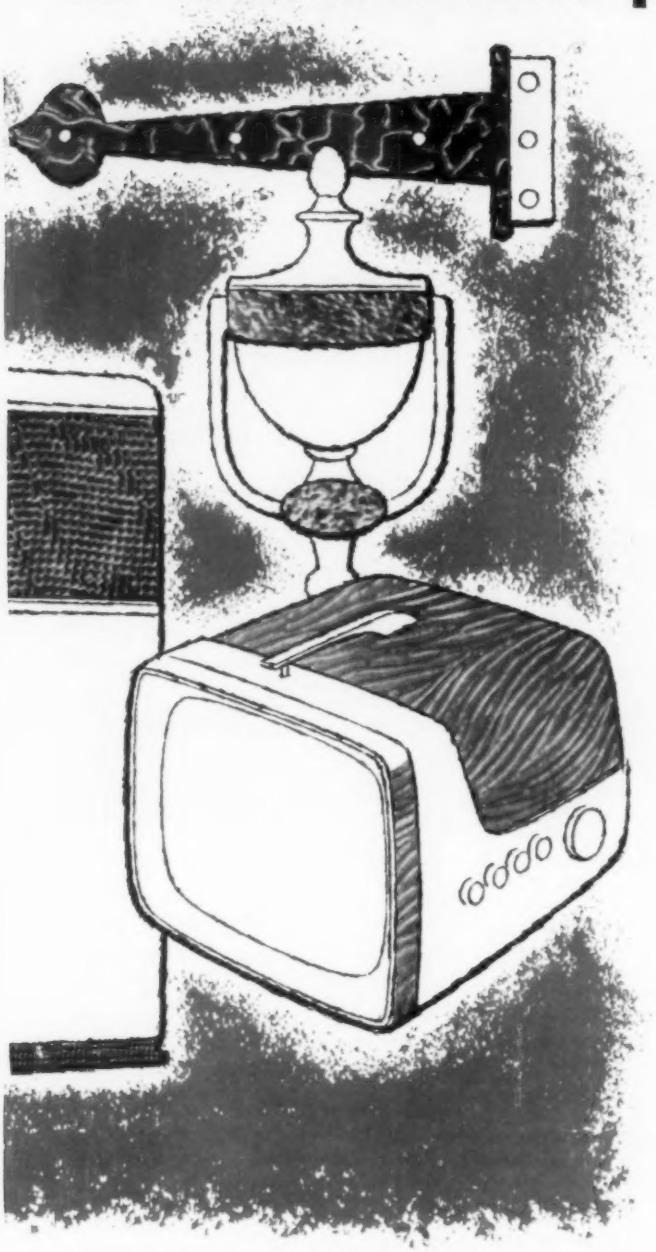
New way to





New patterns . . . Here are 19 new embossed Amerstrip patterns. They can be used on any consumer product made of strip steel, such as: escutcheons, hinges, door knockers, TV and radio cabinets, lamps, table tops, trays, dashboards and kick panels, small appliances, and large appliances.

add beauty and "sell" to consumer products



. . . embossed USS Amerstrip

HERE are just a few examples of the way in which embossed Amerstrip steel can enhance the beauty—and salability—of products made with strip steel. And this is *permanent* beauty . . . beauty you add to your consumer products at low cost.

New embossed Amerstrip is an inexpensive way to add charm and distinction to products because you do not have to apply the pattern; the designs are etched on rolls, then pressed into the strip at our strip mill. Once these patterns are applied, they cannot come off; they are permanently rolled into the steel. A wide variety of new patterns are now at your disposal. Embossed Amerstrip has been experimentally fabricated into products to prove that cold drawing does not affect the pattern. It actually draws easier because the pattern helps hold the lubricant.

Embossed Amerstrip has any number of possible applications, including automobile trim, appliances, hardware, and furniture. New embossed Amerstrip—like all types of Amerstrip—is made to meet the standards of highest quality. American Steel & Wire Division has a large, competent technical staff to help you select the embossed Amerstrip your product needs. Put extra beauty—and customer appeal—in your product with embossed Amerstrip Cold Rolled Strip Steel. For full information, call our nearest sales office. American Steel & Wire, 614 Superior Ave., N. W., Cleveland, Ohio.

USS and Amerstrip are registered trademarks

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NEWS FROM FLEXONICS

HOSE APPLICATION ENGINEERING

One of a series of reports on more effective use of flexible hose.

HOW TO DETERMINE MAXIMUM PRESSURE

for connections made with flexible metal hose

Determination of maximum allowable pressures for metal hose connections has long been surrounded with confusion. A mass of conflicting information has made the designer's job unnecessarily difficult. Recognizing these problems, Flexonics Corporation has developed simple procedures for establishing connector specifications to meet required pressure requirements.

Four Factors Influence Pressure Limitations

In arriving at the maximum allowable pressure for any flexible metal hose connector four factors must be considered:

1. Size, type and material of hose.
2. Method of fitting attachment.
3. Service temperature of hose assembly.
4. Nature of pressure (constant, pulsating or shock).

No connector can be properly designed without consideration of *all* of these factors.

Type of Hose–The size, construction and type of metal of a given piece of hose determine its ability to withstand pressure. The Flexon Metal Hose Design Guide gives maximum allowable pressure for all types, sizes and materials of Flexon metal hose. Use these values as the basis of your calculations.

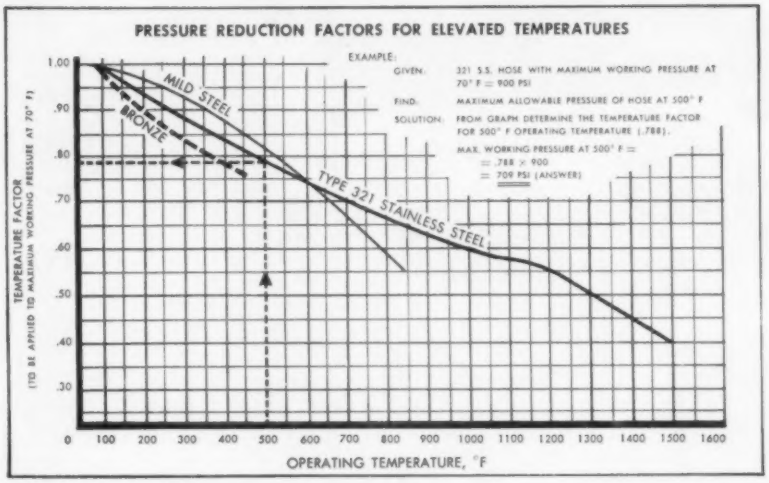
Method of Fitting Attachment–The manner of fitting attachment frequently modifies the maximum pressure rating of a hose assembly. Following are factors for calculating the constant working pressure rating of hose assemblies: (In all cases multiply the maximum allowable pressure as given in Flexon hose specifications by the factor to get maximum constant working pressure.)

I Soft Solder Fittings:
- A. For bronze or steel hose: 1.25
- B. For stainless steel hose: 1.00

II Rex-Tite Mechanical Reusable Fittings:
- A. For braided bronze or steel hose: 1.10

III Packed-On Fittings:
- A. For interlocked Rex-Tube pressure hose: 1.00

IV Brazed or Welded Fittings:
- A. For bronze or steel hose: 1.00



B. For stainless steel hose —
1. **attachment by silver brazing: 1.00**
2. **attachment by atomic hydrogen welding: 0.65.**
3. **attachment by Heliarc welding, braid sleeve type construction: 0.80.**
4. **attachment by Heliarc welding, welding ring type construction: 1.00**

Service Temperature of Assembly–Maximum allowable pressures for Flexon metal hose are given for 70° F. Hose assemblies to be used at temperatures above this must have a reduction factor applied. The graph above shows these factors for three of the metals most commonly used in hose construction. Apply this factor to the pressure value determined by applying the fitting factor to maximum allowable pressure of the hose.

Nature of Pressure–Whether the pressure is constant, shock or pulsating has an important effect on maximum allowable pressure for a hose assembly. For constant pressure, no factor is required. However, for shock and pulsating pressures, a factor must be applied to compensate for stresses set up by this type of pressure.

Working pressures for pulsating conditions are normally ½ the constant working pressure.

Working pressures for shock conditions are normally 1/6th the constant working pressure, where the duration of shock pressure is up to 3 seconds.

These factors are based on extensive laboratory testing. However, for critical applications check with your Flexonics sales engineer.

Design Assistance

Further information on all aspects of hose design is presented in the 36-page Flexon Metal Hose Design Guide. You'll find this to be the most complete and authoritative handbook on metal hose design problems. Be sure and have a copy in your files. It's yours for the asking. Write today.

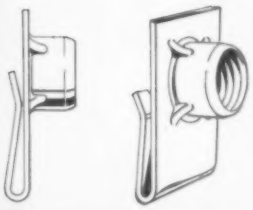
If you have a specific design problem, Flexonics' design engineers will be pleased to assist you. Just send an outline of your requirements.

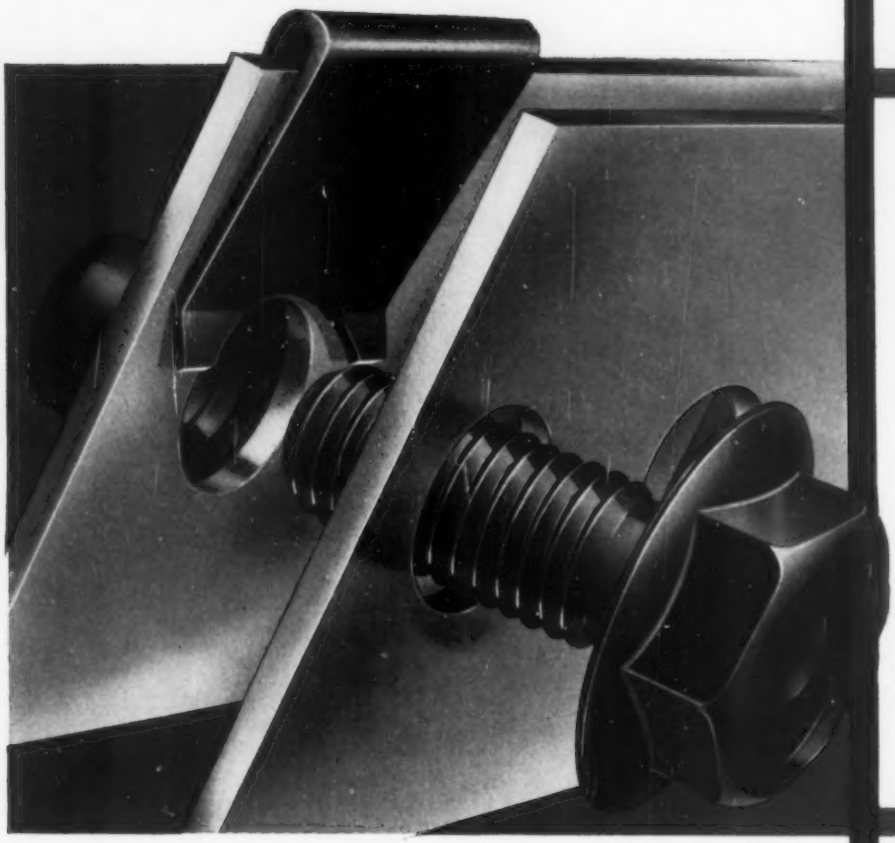
HOSE DIVISION
MH-41

Flexonics *Corporation*

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS
In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario
Also Manufacturers of Rubber and Metal Hose Assemblies • Expansion Joints • Aircraft Components

DOT makes J NUTS with a difference





- FLUSH SEATING
- SELF-RETAINING
- SELF-TENSIONING
- LOW COST
- CAREFUL WORKMANSHIP

It takes a little extra care in the drawing operation to make really reliable J-nuts in volume but it's well worth the trouble. It reduces internal strains in the barrel so that DOT J-nuts stand up to working loads considerably better than the average fastener of similar construction.

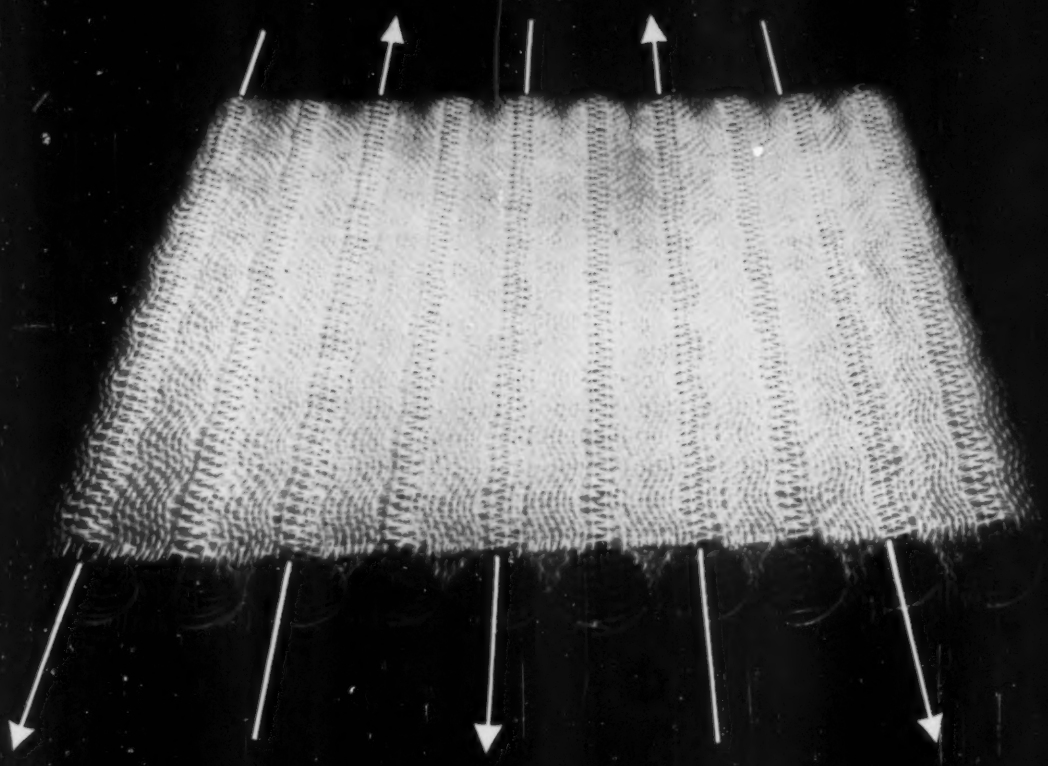
Available in three thread sizes (5/16″-18 and 24, 1/4-20) and to fit three ranges of material thickness (.030″ to .065″), DOT J-nuts are made of carbon steel. They hold themselves in place over stamped holes so that preassembly is practical in cases where the actual bolting operation comes at the end of a series of other operations.

Full details on request.

CARR FASTENER COMPANY

Division of United-Carr Fastener Corporation, Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

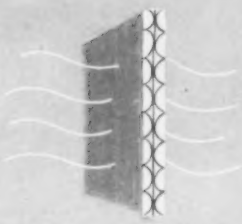


HOW CAN YOU USE TRILOK®... THE 3-DIMENSION STRUCTURAL FABRIC WITH LATERAL POROSITY?

TRILOK'S *stabilized* 3-dimensional form is produced by employing differential shrinkage between polyethylene fibers and Saran® or nylon fibers in the weave. First used for upholstery, TRILOK—*in new forms*—is now finding wide use throughout industry. *Lateral porosity* is one reason. Under extremely low back-pressure, air, liquid or extra-fine particles can pass through TRILOK, which greatly resists compression and "pinching-off". In addition, because of its cushioning properties, TRILOK is often specified for shock-absorbing purposes. In fact, TRILOK has proved to be the answer wherever a "spacer" of very efficient volume/weight characteristics is needed.

PROTECTS WINGS AGAINST HAILSTORMS

With TRILOK wing covers protecting delicate wing structures, planes can be parked in the open and serviced by "wing-walkers". Porosity of the fabric also lets water drain easily.



ENDS METAL WIRE RUST IN FILTERS

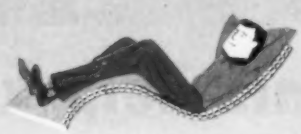
TRILOK, in any of eight standard weaves, is an extremely efficient filter material; has none of the drawbacks of metal bases which corrode during passage of various "batches".

VENTILATES PROTECTIVE GARMENTS

Besides offering protection, TRILOK helps keep personnel comfortable. Heated or cooled air can be passed through the garment and perspiration evaporates naturally.

RELIEVES BED IRRITATIONS

A bed-pad of TRILOK allows a constant stream of fresh, healthful air to cool the patient's skin; prevents excessive moisture build-up through natural evaporation.



MAKES SEAT CUSHIONS SELF-VENTILATING

With a TRILOK seat-section, air can move freely beneath the body. All areas experience the same temperature sensation, excessive "spot" perspiration build-up is prevented.

OPENS NEW DESIGN VISTAS

In literally hundreds of laboratory and field experiments ranging from acoustical applications to medical-treatment procedures, TRILOK is proving a most versatile fabric.

THESE TRILOK PROPERTIES MAKE NEW DESIGN IDEAS PRACTICAL!

- High degree of resistance to all chemicals
- Does not mildew or corrode
- Excellent tensile strength and abrasion resistance
- Is lightweight per unit of thickness
- Excellent recovery and resiliency properties
- Can be engineered, to exhibit more pronounced resistance to compression and shock
- Fabrics are available in eight standard weaves and range in thickness from 1/10" to $1\frac{3}{16}$", from smooth double-faced fabrics through single- and double-faced textures

TRILOK OPENS NEW DIMENSIONS IN DESIGN

For a U. S. Rubber TRILOK engineering representative, write or call address below.

Textile Division

United States Rubber

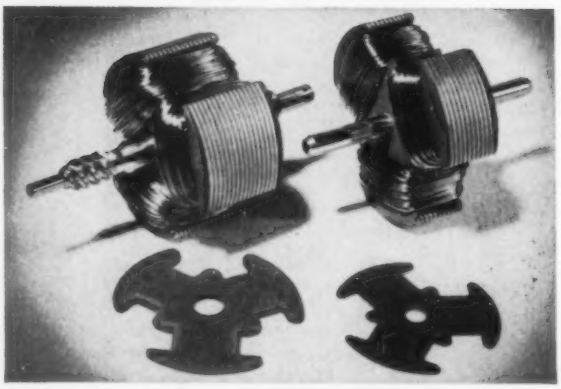
Rockefeller Center, New York 20, N. Y.

Taylor insulating materials help keep Lionel trains rolling, too

Model trains and the giant real things use hundreds of vulcanized fibre and laminated plastic parts. Designers rely on these materials because of high reliability and low cost.

Although primarily applied as insulating materials in electric motors, power supply units, track elements, locomotives and cars—there are many instances where the unique mechanical properties of these materials are effectively put to work. An example is the use of laminated plastic gears (silent gear stock) to transfer power from electric motors.

You, too, may have applications where Taylor vulcanized fibre and laminated plastics will cut costs and improve product reliability. Our application engineers will be glad to discuss them with you. Both our plants—Norristown, Pa., and La Verne, Calif.—are equipped for prompt supply of basic materials or fabricated parts. Write us for details. TAYLOR FIBRE CO., Norristown 39, Pa.



Taylor Vulcanized Fibre Parts Insulate the rotors used to power Lionel model engines. Photos supplied by courtesy of The Lionel Corporation.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

New- Small Sizes!

EATON DYNA-TORQ

MAGNETIC-FRICTION CLUTCHES and BRAKES

Now Available in a Full Line from 1¾" to 15" Diameter

STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The new smaller sizes and new design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this new illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.

Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

LIMA Crane uses USS Shelby Seamless Tubing for strong, lightweight boom

The giant 190-foot-long boom on this Lima Type 802 Crane is strong and rigid, yet remarkably light in weight and completely maneuverable. The Construction Equipment Division of Baldwin-Lima-Hamilton Corporation, Lima, Ohio, fabricated the boom from USS Shelby Seamless Steel Tubing made of very high-yield-strength USS "T-1" Steel. They state many advantages are accrued because of the use of "T-1" Steel Tubing:

- a stronger boom with less weight
- a longer boom without affecting the rated stability of the machine
- no auxiliary help needed in hoisting the boom from the horizontal

Shelby Seamless Mechanical Tubing in all steel grades offers strength and rigidity in perfect proportion to its size and weight. Moreover, it is shock absorbent, uniform throughout, and dimensionally accurate. All Shelby Seamless Tubing is produced under exacting quality control standards and to rigid specifications.

Consult our engineers about the wide range of shapes, diameters, wall thicknesses and steel analyses available. They can help you adapt Shelby Seamless Mechanical Steel Tubing to your particular requirements.

USS, Shelby and "T-1" are registered trademarks

"The world's largest and most experienced manufacturer of tubular products"

National Tube Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

When you buy Motor Starters --

YOU PAY FOR OVERLOAD PROTECTION

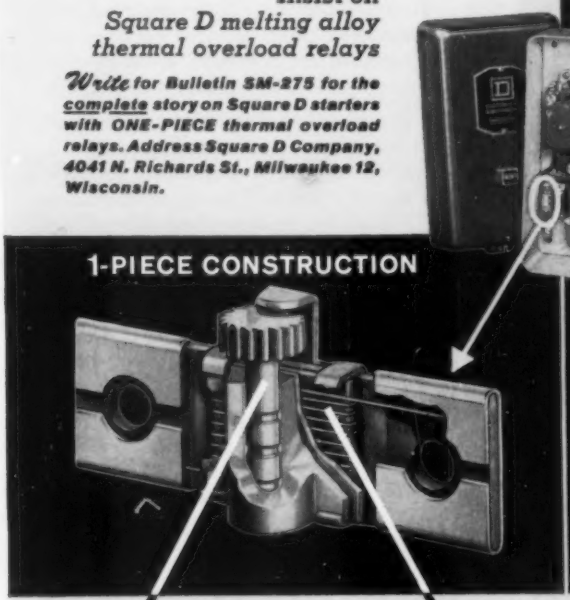
...BE SURE YOU GET IT!

Only ONE-PIECE Overload Relays give 100% Protection • Only with ONE-PIECE construction can you *know* you've installed the heater correctly. Only with ONE-PIECE construction can you *know* the heater is exactly centered, or properly positioned, so that it performs according to its rating. Only with ONE-PIECE construction can you *know* your motors have full protection.

Only Square D has ONE-PIECE Construction • ONE-PIECE construction *eliminates* any possibility of heater misalignment. Square D melting alloy thermal overload relays can be installed only one way. They are tamper-proof. They are factory-assembled, are *individually* calibrated and tested. Repeated tripping will not affect accuracy.

Insist on Square D melting alloy thermal overload relays

***Write** for Bulletin SM-275 for the complete story on Square D starters with ONE-PIECE thermal overload relays. Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.*



Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

Individual factory inspection of every Square D melting alloy thermal overload relay means performance you can trust. Each unit is calibrated and thoroughly tested to make sure it will perform according to its rating.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

←CIRCLE 147 READER SERVICE CARD

CIRCLE 148 READER SERVICE CARD

WHAT MATERIAL

SEEBURG STEREOPHONIC PHONOGRAPH

5082

IS ALWAYS NEW?

BAKELITE
BRAND
PLASTICS

...offering new freedom in design...and cost... and functional advantages!

It continually appears in *new* compounds and forms to meet new specifications.

It encourages the creative talents of design engineers, architects and interior and industrial designers.

You *know* the answer—BAKELITE Brand Plastics.

And BAKELITE Brand Plastics almost invariably offer cost, production, and functional advantages *as a plus!*

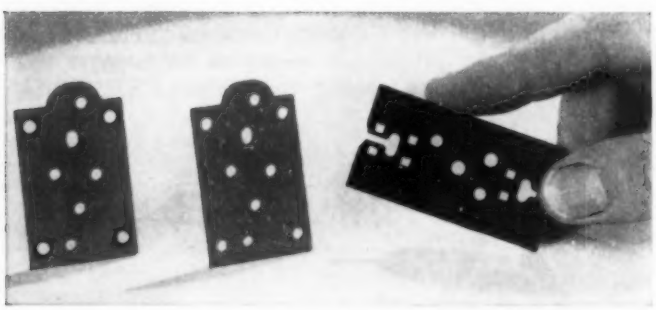
An example of the improvements in design made possible by BAKELITE Brand Plastics is shown at left. It is the first electronic brain, or memory unit, for music machines and jukeboxes. This assembly replaces the old electro-mechanical relay system of record selection and programming, which had moving parts that could wear out or fail.

Whatever your design area, no matter how unusual the qualities you require for forming, strength, rigidity, flexibility, insulation, corrosion resistance—explore the proven advantages of BAKELITE Brand Plastics and Resins. The material that's new all the time!

Technical representatives with years of training and field experience are available to discuss your special design problems. Write Dept. LX-520.

BAKELITE Brand Polystyrene was chosen to encase this domestic food waste disposer...another example of a plastic meeting **exact** specifications. Ease of molding was required for the graceful design, along with chemical inertness, resistance to heat, attractive color and luster, durability and high impact strength. Molded of BAKELITE Brand TMDB-5161 for Waste King Corp., Los Angeles, by Modern Plastic Co., Los Angeles, and Industrial Molding Corp., Culver City, Calif.

* * *

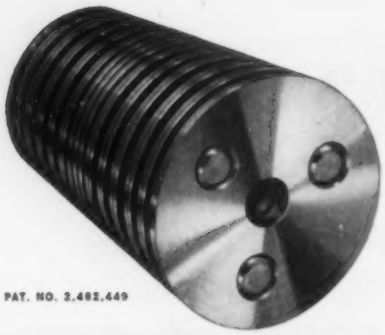


BEARING PLATES and TERMINAL BOARDS of "BAKELITE" Brand Phenolic are important components in the new automatic memory unit shown on the left-hand page. Using miniature toroid cores made of powdered ferrite material, operation is similar to that of giant electronic brains. BAKELITE Brand Phenolic was chosen for its excellent electrical insulation properties, high temperature resistance, impact strength, and dimensional stability. Developed by The Seeburg Corporation, Chicago, with parts molded by Mayfair Molded Products, Schiller Park, Ill., and stampings by Fibre Fabricators and Spaulding Fibre Company, both of Chicago.

UNION CARBIDE PLASTICS COMPANY
Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.
In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Toronto 7
The terms BAKELITE and UNION CARBIDE are registered trade-marks of UCC.

BAKELITE COMPANY
has a new name...
UNION CARBIDE PLASTICS COMPANY
DIVISION OF UNION CARBIDE CORPORATION

CIRCLE 149 READER SERVICE CARD



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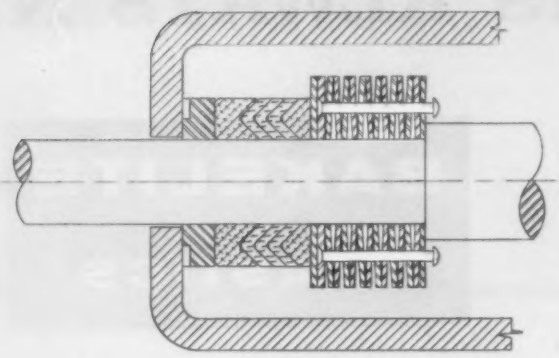
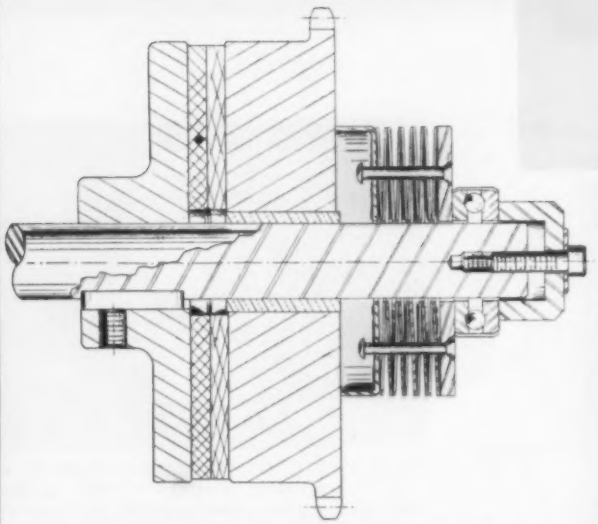


Typical installation of a "cartridge" of multiple Belleville washers in a shaft seal.



Typical installation of a "cartridge" of multiple Belleville washers in a clutch, such as in a machine tool drive.

Some uses of Belleville Washers as a spring ENERGY CARTRIDGE

Where loads are high, operating space limited, and conventional spring forms fail to qualify, Belleville washers in the form of an Energy Cartridge can be a welcome solution. Two such conditions are illustrated here.

By preassembling the washers in a single compact unit held together by pins or posts, installation is simplified and error is prevented in stacking loose washers in sequence. For varying loads, many combinations are available: in series, parallel or parallel series.

Belleville washers may be used for vibration isolation, as spring mountings for punch and impact presses, or to maintain constant pressure. For further information, write for pamphlets "Belleville Springs" and "Energy Cartridge." For engineering and production assistance on large or small requirements, contact the nearest A.S.C. Division listed below.

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
F. N. Manross and Sons Division, Bristol, Conn.
San Francisco Sales Office, Saratoga, Calif.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

5812

first in silicones

Dow Corning

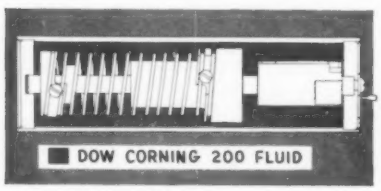
SILICONE NEWS

for design and development engineers • No. 57

ASSURE UNIFORM DAMPING, USE STABLE SILICONE FLUIDS

You can be sure of maximum stability and uniform performance when you specify silicone fluids for damping, springing or driving media. The new accelerometers developed by AiResearch Division, The Garrett Corporation, provide a good example.

With Dow Corning 200 Fluid serving as the damping medium, these spring-loaded potentiometer type accelerometers maintain a high degree of accuracy and reliability at temperatures ranging from —65 to 350 F. The accompanying table makes it easy to see why. The silicone fluid's near-constant viscosity over the operating temperature span of these units, plus excellent resistance to oxidation and to breakdown due to mechanical shear, offered AiResearch just the right combination of properties for high accuracy, low maintenance and long service life.



Available models, that range from 1g to 10g, may be substituted without need of adjusting or calibrating associated equipment—an advantage attributable to versatile Dow Corning 200 Fluid. *No. 583*

PHYSICAL PROPERTIES OF DOW CORNING 200 FLUID (50 Centistokes)

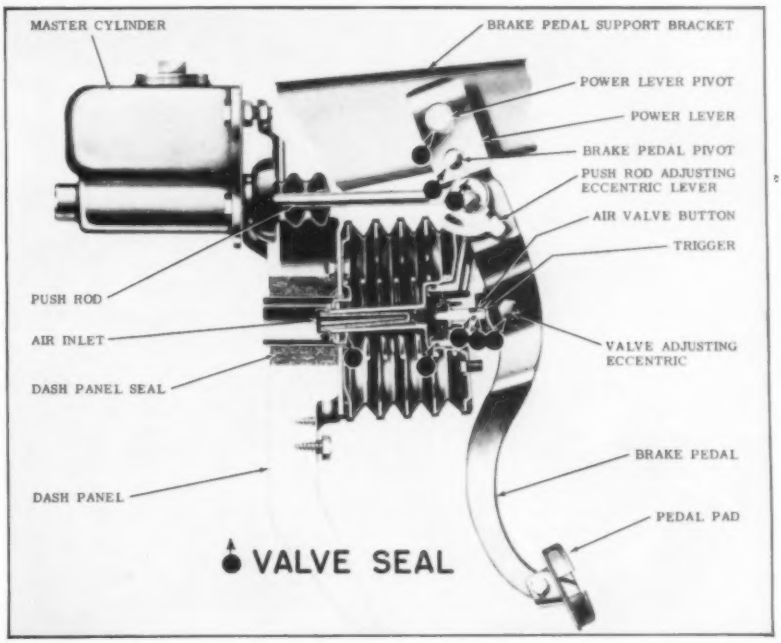
Viscosity in SSU, at 100 F	185
Viscosity-Temperature Coefficient[1]	0.59
Pour Point[2]	—67 F
Boiling Point at 0.5 mm Hg pressure	482 F
Flash Point[3], Minimum F	535
Thermal Conductivity[4]	0.00036
Coefficient of Expansion cc/cc/°C	0.00104
Surface Tension, dyne/cm	20.8
Specific Gravity, 25 C/25 C	0.960

[1] $\frac{1-V210\ F}{V100\ F}$

[2] Pour point ASTM D97-39, sections 5 to 7.

[3] Open Cup, ASTM D92-33.

[4] $\frac{g\text{-}cal}{sec \times cm^2 \times C}$ at 50 C



HOW TO LUBRICATE AND PROTECT RUBBER PARTS

What one material can you specify to lubricate rubber parts and protect them during assembly, storage and rugged service? Kelsey-Hayes engineers will tell you it's Dow Corning Valve Seal.

For over six years, Kelsey-Hayes Co. has been using this silicone compound on the rubber diaphragms and seals in its automotive power brake assemblies for trucks, buses and passenger cars. Nonreactive to both natural and synthetic rubber, a light coating of Valve Seal lubricates the parts and keeps them soft and pliable; it increases their efficiency and extends their service life.

In addition, company engineers report, this silicone compound has reduced damage to the delicate rubber parts during assembly, and has made it easier to slip the parts in place.

Nonbleeding, nongumming and nonoxidizing, this silicone compound is virtually indifferent to heat or cold. As a result, it provides efficient lubricity even after long service at temperature extremes. *No. 582*

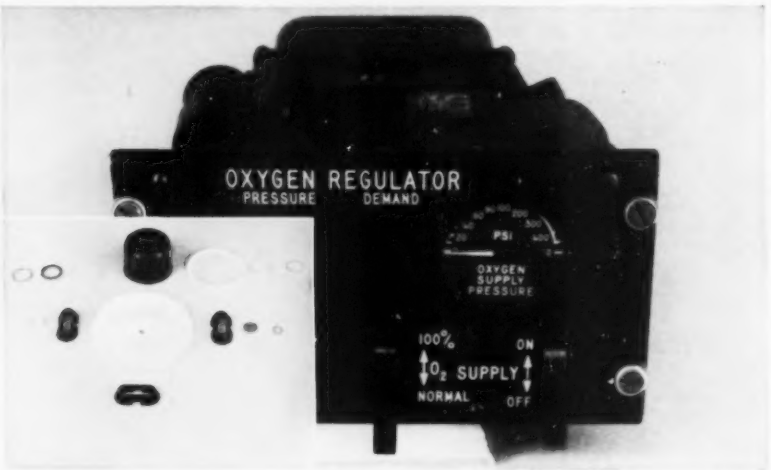
Santa Claus Gets An Assist From Silicones

They say St. Nick stops fretting over his big stock of colorful toys when his helpers discover how efficiently Dow Corning Silicones lubricate the plastic parts and keep them in good working order.

Santa's helper in this instance is Knickerbocker Plastics of Los Angeles, producer of a popular, 2-way water pistol for junior spacemen. Knickerbocker's *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE



SILICONE RUBBER PARTS RESIST PROLONGED EXPOSURE TO OXYGEN

New evidence of the exceptional oxidation resistance of Silastic®, the Dow Corning silicone rubber, is the long life of Silastic parts in oxygen regulators produced by the Pioneer-Central Division of Bendix Aviation Corporation, Davenport, Iowa.

These sensitive mechanisms, which control the mixture and flow of life-sustaining oxygen to airmen at high altitudes, utilize many rubber parts for valve seats, sensing diaphragms and static seals. When made of organic rubber, they deteriorated so rapidly that both military and commercial regulations required that a service record be kept on each part.

This meant frequent dismantling of equipment to replace outdated parts — a time-consuming, costly operation. Some parts, held in storage for long periods, were scrapped even before going into service.

Made of Silastic, however, these parts are relatively unaffected by exposure to pure oxygen. They show no change in properties long after organic rubber parts have hardened and cracked. They retain excellent elasticity, low compression set and hardness over the full operating temperature range from —65 to 160 F. Their long service life has substantially reduced replacement and overhaul costs on oxygen regulators, according to Bendix engineers.

Parts featured in this application are made of various low-temperature Silastic compounds to achieve desired properties. Other Silastic compounds with exceptional resistance to fuels, oils and solvents are also finding growing use in the aircraft, automotive, appliance, electrical and process industries. *No. 585*

SILICONE FLUID *(Continued)*

records over the past five years clearly show that the farther and more accurately these pistols shoot, the better they sell.

Design problem: how to keep the tight-fitting parts in these mass-produced pistols from binding while holding to the tolerances required for best performance.

Knickerbocker's solution: apply a drop or two of Dow Corning 200 Fluid to the pistol's wearing parts. The nonoxidizing, nongumming silicone fluid provides just the right amount of lubricity to keep the plastic parts from binding for the entire lifetime of the water pistol.

Result: no misfires; more sales. *No. 584*

new literature and technical data on silicones

How equipment can be designed to increase production, reduce maintenance and save in space and weight is told in a 30-minute, full color, sound movie, More Muscles for Tomorrow. Get a folder explaining how to arrange for a showing by circling . . . . . *No. 586*

Stop sticky products from sticking. Paper and paperboard with a Syl-off anti-adhesive coating pulls away cleanly, easily from all gummy and tacky materials enabling you and your customer to save time and money. Approved sources and manufacturers of boxes, bags, innerliners, wrappings and interleaving sheets with Syl-off coatings are listed in individual bulletins for quick, easy reference. *No. 587*

Simplify design, improve performance, cut costs, and add new sales appeal to your products with Dow Corning Silicones. A sixteen page, cross indexed Guide to Dow Corning Silicones filled with data and illustrations suggests numerous ways to do this. *No. 588*

Easy-to-use encapsulating materials now commercially available for electrical and electronic equipment. A combination of suitable fillers with solventless silicone resins provides an encapsulating material that has good pot life and, on curing, sets to a solid mass having good electrical and physical properties that assure long service life at elevated temperatures. *No. 589*

More flexibility in design is possible by specifying Dow Corning 44 Grease in ball-bearing equipped fans, motors, and similar units for high ambient temperature locations. This silicone lubricant offers improved resistance to oxidation, thermal decomposition and shear breakdown. A four-page brochure gives pertinent facts. *No. 590*

To bond silicone rubber more effectively to metal or to itself, Silastic Adhesive S-2200 is easily applied and vulcanizes quickly. Tests affirm its marked superiority over previously available adhesives. *No. 591*

Need more serviceable plastic parts? Dow Corning silicone molding compounds offer outstanding physical and electrical properties, are specified by designers for a variety of applications where organic plastics fail within a relatively short time. *No. 592*

Dow Corning Corporation, Dept. 0612, Midland, Michigan

Please send me: 582 583 584 585 586 587 588 589 590 591 592

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

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FAFNIR ANNOUNCES NEW, MODERN, COST-CUTTING DESIGNS IN SEALED BALL BEARING PILLOW BLOCKS!

LSA Standard Duty

LSAO Heavy Duty

Protection, economy, design-appeal featured in new LSA and LSAO standard and heavy duty units

Introduction of Fafnir LSA and LSAO pillow blocks opens new opportunities for improving both machine performance and styling, and reducing costs in standard and heavy duty applications.

Equipped with integral seal, wide inner ring ball bearings, the units are positively protected against contaminants and loss of lubricant. Fafnir-originated self-locking collars permit fast, easy, cost-cutting installation. Moreover, though the new series are made to the same base-to-center height dimensions and bolt-hole spacings as corresponding sizes in Fafnir's SA and SAO series, they are available at lower initial cost.

Housings are solidly built and of massive, streamlined design to harmonize with modern machine styling. All units are prelubricated and have provision for relubrication, if necessary . . . come ready to mount . . . and are designed to take radial, thrust, or combined loads in any position. Write for new bulletin showing sizes, dimensions, types, features. The Fafnir Bearing Company, New Britain, Connecticut.

FEATURES

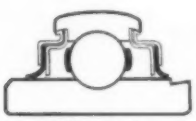
Positive Protection — Slinger-type Mechani-Seals for protection at higher speeds; contact-type Plya-Seals for slow-to-moderate speeds, dirty or wet conditions.

Extra-Sturdy Support — Wide Inner Ring Ball Bearings with deep grooves and large balls for sturdy shaft support.

Simplest Installation — Fafnir-originated eccentric cam self-locking collar provides positive locking to shaft with twist of wrist. No machining, no mounting devices.

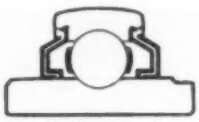
Self-Alignment — Spherical bearing O.D. and corresponding spherical housing seat assure self-alignment in any direction.

Modern Styling — Smoothly finished, streamlined, massive cast iron housing with machined bearing seat and base.



Plya-Seal

Integral Seal Ball Bearings



Mechani-Seal

Bearings in LSA units are Mechani-Seal type — or available optionally with Plya-Seals (RSA). LSAO series bearings are Mechani-Seal type, except those for shaft sizes $3\frac{3}{16}$", $3\frac{7}{16}$", and $3\frac{15}{16}$", which have Plya-Seals (RSAO).

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

BONDERITE

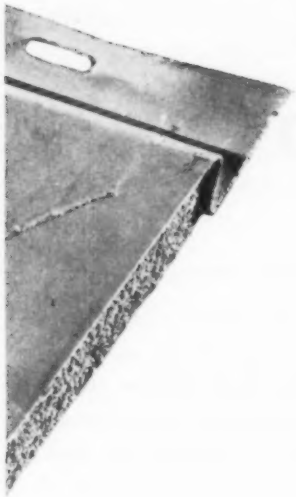
ALUMINUM SIDING TEST

Regular 1-coat paint finish over section of Bonderite treated aluminum siding. Formed after painting. Tested in salt spray 1500 hours.

Aluminum siding made by Hastings Aluminum Products, Inc. Hastings, Michigan

for ALUMINUM

Better paint adhesion...better corrosion control



In two hundred plants—many of them the leaders in their particular fields of aluminum fabrication—Bonderite for aluminum is being used today!

Bonderite makes it possible to take aluminum in the coil, run it through a continuous line in which the strip is cleaned, Bonderized, roll-coat painted, dried—and then recoiled.

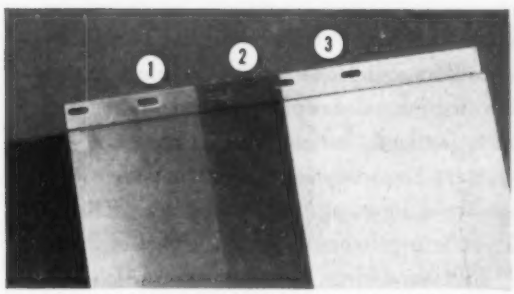
Because Bonderite gives paint such a secure foothold, it will stand severe forming operations (see photo below). With the Bonderite corrosion barrier at work, durability of the paint finish is almost indefinitely prolonged.

Bonderite meets and exceeds the requirements of Government Specification MIL-C-5541. Bare corrosion resistance is outstanding.

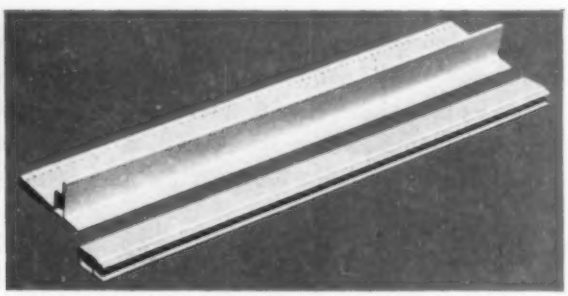
There's more than one type of Bonderite for aluminum. Besides the paint base, there's a Bonderite that creates a pleasant green coating, for use on architectural products. There's a Bonderite which protects without changing the characteristic color of the aluminum. Another Bonderite coats aluminum, steel and zinc—just the thing for mixed production.

There is a Bonderite, in fact, for every form of aluminum production, and for practically every alloy.

The big news in surface treatment for aluminum today is Bonderite! Let a Parker man tell you all about it!



Here's the 1-2-3 for durability of painted aluminum. Section of siding shows bare aluminum, (1); Bonderite treated, (2); and roll-coated paint, (3).



These aluminum window and screen frame sections were Bonderized and painted in the strip and formed after painting. There isn't a break in the finish anywhere!

Since 1914—leader in the field

PARKER RUST PROOF COMPANY

2179 E. Milwaukee, Detroit 11, Michigan
Tel: TRinity 5-3377

BONDERITE corrosion resistant paint base	BONDERITE and BONDERLUBE aids in cold forming of metals	PARCO COMPOUND rust resistant	PARCO LUBRITE wear resistant for friction surfaces	TROPICAL heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

In financial aid to education . . .

What Should Business Do Now?

Now that the federal government is entering the field, should business firms stop giving financial aid to our colleges and universities?

This question is now being discussed by business directors throughout the country. The discussion is prompted by the near-billion-dollar program of federal aid to education passed by Congress a few months ago. For if the federal government, with its access to billions in taxes, is assuming responsibility for the financial welfare of education, should not business get out of the way and let the government take over? This is the general way the question is being asked.

The answer is a resounding NO.

What The Federal Program Does

The new federal program makes it possible for the government to spend the imposing total of $900 million for aid to education over the next four years. There are still many loose ends in the program. But already it's quite clear what such funds will — and will not — do to help relieve the financial plight of our colleges and universities.

First of all, the program is not going to solve any financial problems in education overnight. The program is just barely underway. So far no money has actually been allocated, and Congress has appropriated only $40 million — less than 5% of the total.

More important, there is very little in the total program which will result in direct aid to colleges and universities. The program does set up fellowships to train college teachers. But most of the aid will eventually be channeled through the states to primary and secondary schools. The main focus of the program is education for national defense — strengthening science, mathematics and foreign languages in elementary and secondary schools, together with grants for counseling, testing and research.

The one big item for higher education is a $295 million student loan program, which will help needy students pay tuition and other fees. But tuition rarely covers the full cost to the college of educating a student. So the net result could well be an additional financial strain on our institutions of higher learning.

For the three most pressing financial needs — faculty salaries, scholarship grants and new plant and equipment—colleges and universities must still rely heavily on help from the business community. And it would indeed be a major

misfortune if the recent actions of the government put a blight on this growing and substantial support to higher education.

In the last ten years, business has expanded its financial aid to education by more than four fold. In 1948, contributions were only $24 million. In 1957, such aid reached an estimated $125 million. Moreover, corporations have been putting a larger proportion of their total charitable gifts into education. In 1950, the percentage was only 17%. By pre-Sputnik 1956, the share had already increased to 34%, according to figures recently released by the Council for Financial Aid to Education.

Why Business Must Help

The most compelling reason for increasing business aid to higher education — at an even faster rate—is that our colleges and universities desperately need financial help. It is that simple. Private contributions to higher education must average at least $400 million over the next ten years if our colleges are to meet rising operating costs and raise faculty salaries to decent levels. Despite the growth in business contributions, we are still well below that goal.

If our colleges cannot solve their mounting financial difficulties through voluntary help from business firms, alumni and communities — then it is to be expected that federal aid ultimately will be mobilized in a big way. In principle, if not in dollars, the 85th Congress has paved the way. Indeed, a large federal scholarship program was squeezed out of this year's legislation only in the course of last-minute compromises. And Arthur S. Flemming, Secretary of Health, Education and Welfare, has urged that the next session of Congress restore the scholarship program.

About any federal rescue operation for higher education, two things are quite clear:

(1) **Such aid will come too late to prevent irreparable harm resulting from the current shortage of funds.** The need for help is urgent and immediate.

(2) **With federal taxes taking over half of all corporate income, any federal program in the end will be financed in large part by the business community.**

An Opportunity

So, viewed narrowly, it is in the selfish interest of business firms to aid our colleges and universities now, rather than wait and be forced to pay later on. By doing so, they ensure that business will have a continuing supply of well-trained graduates. They take advantage of the tax laws for charitable contributions which mean the government in effect assumes more than half the cost of business aid to education. And they win gratitude for a voluntary and generous act.

Viewed in the broad public interest, the business community has an opportunity to perform a financial rescue mission in education which could well be the key to successful survival, not only of our present system of higher education, but also of the nation itself.

As previous editorials in this series have pointed out, a very small share of the net income of business firms — about 1% — would do the job. Certainly business must not be distracted from this opportunity by the new venture of the federal government in financial aid to education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

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One-quarter turn . . .

CLOSED

One-quarter turn . . .

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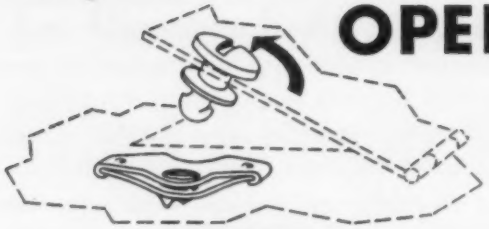

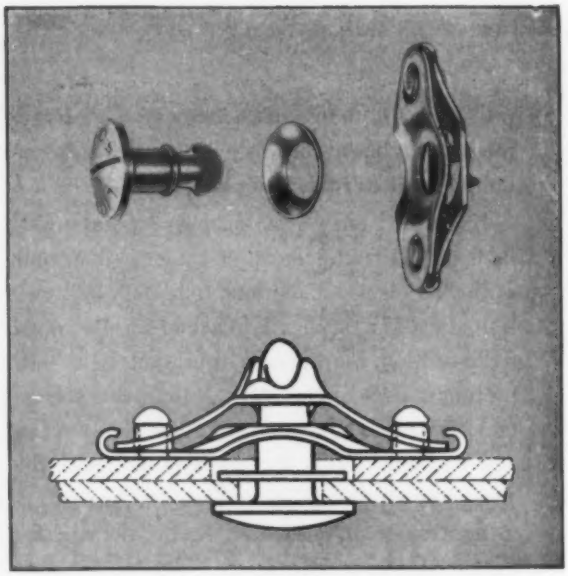

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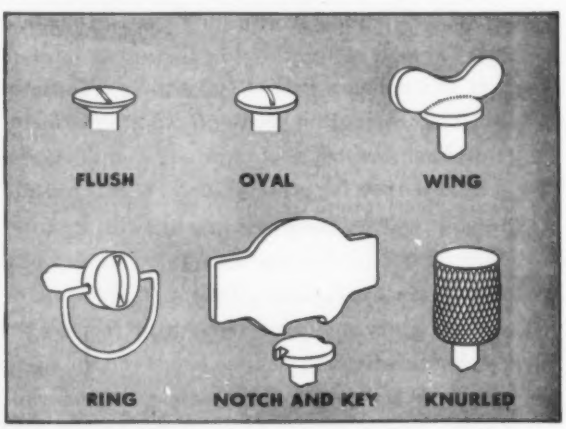

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For complete information on Lion Quarter-Turn Fasteners, as well as on the complete Southco line, write today to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

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PERSPECTIVES

in design and development . . .

Technical Trade with Russia

Can the US carry on technical trade with Russia? Certainly, but Russia would have us believe that the total amount would run into the billions of dollars. That is not the case, according to the Bureau of Foreign Commerce (BFC) of the US Department of Commerce. Instead, the figure is much closer to some millions of dollars. "An analysis of the Russian trade inquiries," according to Frank Sheaffer, Acting Director of Export Supply of the BFC, "makes it abundantly clear that the US is looked upon only as a supplier of specialties—of advanced technology—and the few items of equipment that can't be bought elsewhere."

For the most part, when Russia talks of making many purchases of a wide variety of products from the US, they are merely probing. According to the BFC's records, no more than 50% of the orders received from Russia become actual shipments. The other orders are usually cancelled at the last minute. At one time, only 8% of the goods that were ordered were actually shipped. "Actually," says Mr. Sheaffer, "the amount of trade is limited by a practical consideration: Russia does not have ability to sell enough in the US market to support much trade expansion. The products offered for trade by that country—plastics, refrigeration equipment, mining machinery, construction machinery, television equipment, you name it—are being supplied to us in ample quantities by friendly nations."

Before a US company may export to the USSR, it must get a license from the BFC on any commodity not covered by a general license which lists commodities regarded by the US as having peaceful uses. A company must get a license also to export to Russia any technical data, other than any unpublished pure scientific material generally not available.

What Russia Wants

Russia's interest in our advanced technology is evidenced by her inquiries for such items as large petrochemical plants; petroleum refineries; tire and tire cord plants; textile processing plants; synthetic fiber plants; plastics plants—especially polyethylene; and steel-finishing plants—particularly in the high-speed tinning and galvanizing lines.

Among license applications rejected have been those for petroleum refining plants; technical data about petroleum exploration and production; and petrochemicals and plastics with highly strategic applications.

Poland is now in a separate category from other Eastern European countries for export purposes. Except for about 50 commodities and unpublished technical data, exports to Poland are subject to no more restrictions than those to England or Italy. All other countries of Eastern Europe are subject to the same considerations as the USSR and have little resources available for trade with us. Of the total licenses with a value of $23,655,000 approved for the Soviet Bloc in the first nine months of 1958, $13,859,000 was for the USSR and $4,242,000 for Poland; the rest for Bulgaria, Hungary, Czechoslovakia, East Germany, and Rumania.

According to reports from the BFC, analysis of trade inquiries received in the past few months does not point to a "broad and healthy" development. "The Soviets have made considerable progress in the laboratory, and in some instances have succeeded in building pilot plants in some of the fields in which they have expressed an interest in foreign procurement. They have not been successful, up to the present, in the design or construction of modern high through-put plants. It is this stage of development that they want to buy from the West." —Paul Anderson

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Product Engineering **HORIZONS**

December 8, 1958

The "Boss" Is Gone

He was personally the self-starter—as well as its inventor. He was the voice of engineers for several decades when they were otherwise voiceless. He was the rare man who can say important things in pungent phrases, likewise the rare one who could originate both in deeds and in words. Yet he was a humble man, and one who did everything he could for his fellowman.

This was Charles Franklin Kettering, the holder of over a hundred important patents, who still had time to worry about why the grass is green and why and how people die of cancer.

Some people called him the "Boss", some "Mr. General Motors", his intimates knew him as "Ket", but more than all these he was "Mr. Engineer." In an era during which the engineer began to come into his own, he typified the things all engineers would like to be, the versatility, humanity, competency and initiative that are so rarely combined in one man.

His like will not soon pass our way again.

Quotes from Ket

The price of progress is trouble

A research laboratory is not simply a building . . . it is a state of mind

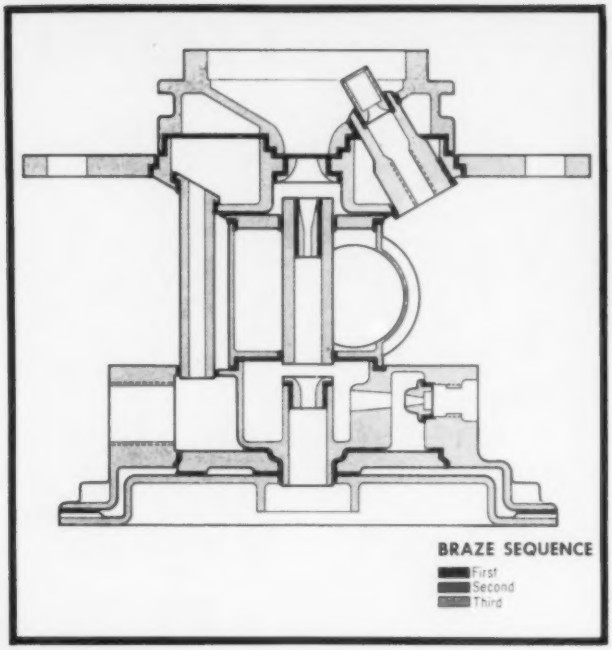
A research organization is the originator of obsolescence

No one would ever have crossed the ocean if he could have gotten off the ship in the storm

Research is an organized method for keeping you reasonably dissatisfied with what you have

F. J. Haugrinan

G D CREMER
Staff Engineer
R S MUELLER
Research Engineer
Solar Aircraft Co



Brazing in 3 steps... made this complex control-instrument body, operated by hot turbojet gases at 1500 F. Diagram shows sequences in which 17 parts are brazed to give the finished unit.

ONE TEMPERATURE FOR SUCCESSIVE BRAZES

Here's how tighter production control with special brazes allows multiple brazing wthout reducing operating temperature of the final assembly. Article includes design advice that can limit rejects to 2%.

The advantages of multiple brazing are now being applied to fabricating parts that will have to work at high temperatures. With careful control, the same brazing alloy and same heat give reliable joints as the assembly grows step by step. A valuable bonus is that, at each step, both the strength of the joints and the operative temperature of the final assembly go up as the braze becomes part of the parent metal.

By contrast:

• High-temperature parts usually are brazed by the conventional one-shot process. Here, components are assembled in a fixture and brazed simultaneously in one fusing heat. But the impracticality of this method increases with the complexity of a part.

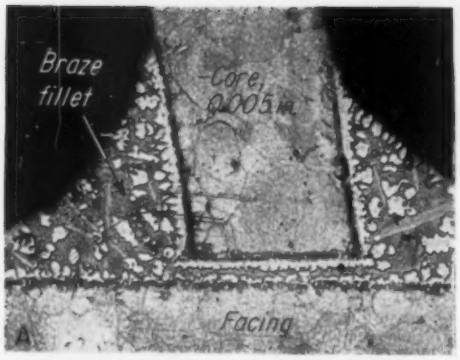
• Older multiple-brazing methods have drawbacks when applied to high-temperature parts. The subsequent brazing steps are limited to lower-melting brazes, like copper and silver—so that brazing heat will not remelt joints already made. Each step drops the service temperature for the assembly.

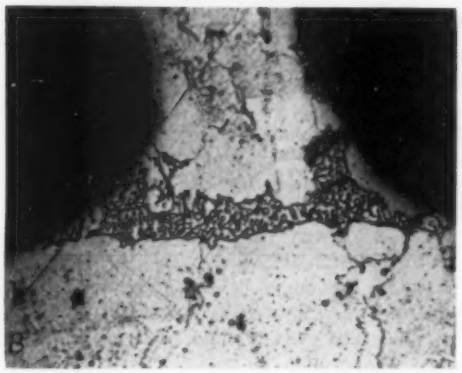
• The new concept allows subsequent brazing without such penalty. Nor is there shrinking or loosening of joints already made. This permits assembling complex precision parts, or repairing brazed joints later. And it simplifies assembly because the strong joints act as their own supports in the step-by-step procedure.

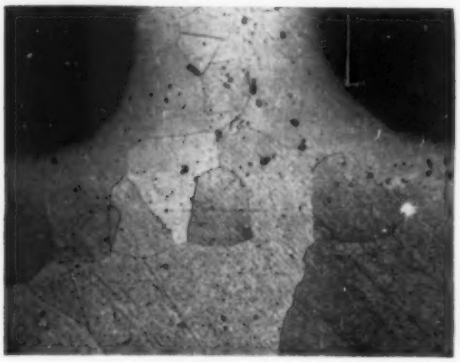
• A big advantage of the new method is the diffusion it stimulates. Each reheating carries certain braze constituents deeper into the base material, until the joint is no longer visible and its melting point has risen to that of the component.

How It Works

In this precise method, which can limit rejects to 2%, merely applying gobs of braze alloy will not work:







Disappearing act...
is shown in three steps as diffusion occurs in brazed joint of honeycomb structure. Both core and facing are Inconel; brazing alloy is Solabraze NX1; brazing temperature is 1950 F. (A) one minute after brazing begins; (B) at 10 minutes, brazing is done and diffusion is well under way; (C) the joint after continued heating to complete diffusion.

• The part should be made of a metal that allows effective diffusion with the brazing alloy.

• Such diffusion generally requires a close-fitting joint, with gap from 0.0005 to 0.0025 in. Wider gaps up to at least 0.010 in. may be brazed by adding certain metal powder constituents to the brazing material.

• A special brazing alloy is needed.

This alloy should be a nickel-base type. Nicrobraz and Solabraze are two examples. They contain small but closely controlled percentages of elements like silicon, boron and carbon which dissipate when the alloy melts. After solidifying, the alloy has a new melting point. For example, Nicrobraz flows initially at 1930 F, remelts above 2100 F. Diffusion of this mutation into the base metal may raise the melting point still further. Diffusion eventually bridges the gap, removing any evidence of the brazed joint.

Built-in Precision

A price must be paid for the precision and dimensional stability of assemblies made this way. Components must fit very accurately. They must also be relatively distortion-free after firing so that subsequent parts will mate. This is not easy. A simple part with two bends may have to be bent, rolled, stretch-formed, rerolled and stretch-formed again before it becomes relatively free of warpage.

Which Material?

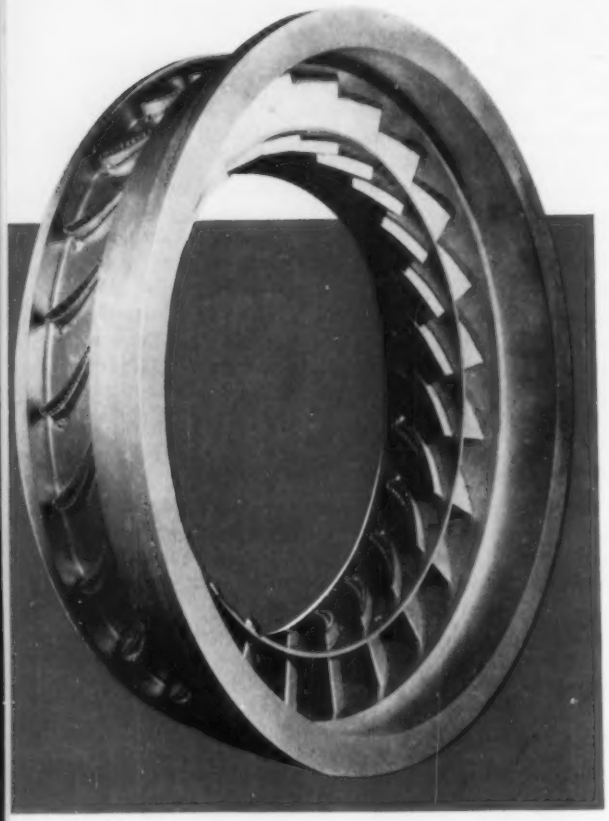
Production brazing cycles have been worked out for a wide range of base metals. Representative alloys, listed in the accompanying table, illustrate the range. Service temperatures given as a guide are based upon those the base metal will withstand before harmfully oxidizing. Estimated max for lightweight parts, such as honeycomb sandwich, is slightly lower because thin foil is generally

SERVICE TEMPERATURES FOR BRAZED METAL ASSEMBLIES

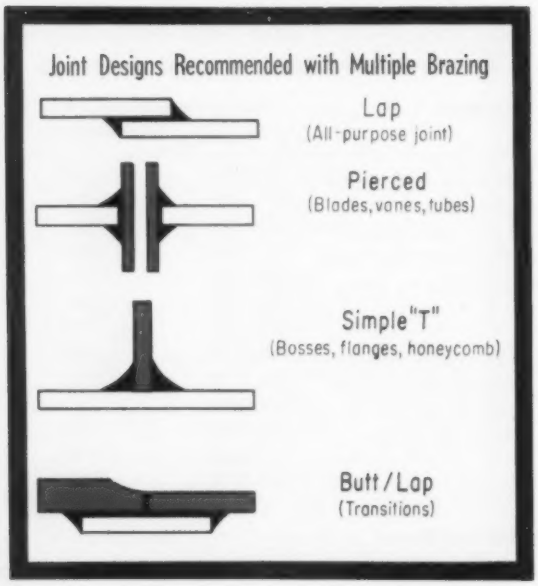
Base Metal	Temperature Range, °F	
	massive parts	lightweight parts*
17-7 PH	700–750	740
AM 350	800–900	900
T-410	800–900	900
5% Cr tool steel	800–1100	1000
A-286	1000–1350	1200
Inconel X	1000–1400	1300
Hastelloy B	1200–1500	1400
T-321	1200–1600	1500
19-9DL	1400–1700	1500
T-310	1200–1800	1700
N-155	1400–1900	1700
Inconel 700	1500–2000	1800
L-605	1500–2200	2000

* Estimated 100-hour life.

ONE TEMPERATURE FOR SUCCESSIVE BRAZES



This gas-turbine nozzle . . .
was brazed twice at the same temperature—first to assemble the air-cooled vanes, then to fix them in place.



more sensitive to oxidation, corrosion, imperfections and variations in processing. In actual brazed parts, these temperatures vary even more because service limits are also affected by stresses on the part, surface treatment prior to brazing, thermal stresses, and effects of heat treatment.

Added Benefits

Frequently, costs of multiple-brazed parts can be lowered by redesign aimed at this process. Right- and left-hand parts may be made as a single subassembly, or thick walls designed as thin double walls; flanges and bosses can be formed from tubing and then brazed-in.

It is difficult to avoid some distortion from the annealing effect of the braze cycle, so a simple sizing operation prior to final brazing will give precise final dimensions within ± 0.001 in. After the final brazing, the assembly is usually so rigid that it cannot be mechanically reworked.

After the last cycle, additional heats may be specified to build up fillet size and seal-fluid passages, to make minor design changes and, in certain cases, to correct dimensions. Diffusion time can be lengthened to raise allowable service temperature of the parts.

New Tricks with Honeycomb

Multiple brazing extends the field for honeycomb. Brazed honeycomb sandwich can be made into parts with "open-faced" sandwich or one side exposed. These exposed honeycombs are particularly good for seals against rotating parts. The rotating part cuts into the honeycomb to give what is in effect a seal with zero clearance. As much as $\frac{3}{32}$-in. interference can be accommodated without damage. Multiple brazing can also adapt full-depth core structures to wedge shapes. By using two sizes of honeycomb—standard cell for thick sections, small, dense cell for thin sections—the thin tapered edges are given added stiffness and strength.

Possible also are lower costs for all brazed honeycomb. Multiple brazing can give a stock panel of honeycomb 1 to 2 feet wide in continuous lengths. This low-cost panel can then be cut and assembled by brazing into complete structures.

EDITOR'S NOTE: Answers to other aspects of design aimed at high-temperature applications are covered in:

Materials—"New Superalloy Bids for Hot Jobs," July 21 '58, p 76, facts and curves compare Rene 41 with other alloys from 1200 to 1800F; "High-temperature Stainless," Apr '57, p 135, compares mechanical properties and structural stability of 8 candidates for between 600 and 1400 F.

Protective coatings—"High-temperature Coatings," Jan 20 '58, for high-temperature resistance to corrosion and erosion; "Hot-dipped Aluminum Coatings," Oct 28 '57, allow substituting cheaper base metals, cut fabricating costs and reduce maintenance.

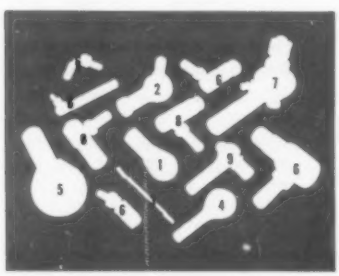
LINKAGE JOINTS

Controlling factor in a linkage is the joint—its form, attachment, unit-bearing loads, bearing clearance, method of lubrication, cost and ease of assembly. Here is a survey of available types and details of a new linkage joint.

HO CHOW, *Vice-president, Westchester Technical Corp*

Basic Requirements for a Linkage Joint
(Ball-type with one-side support)

1. Material distributed for minimum weight and minimum stress concentration.
2. 360° rotation, plus ample allowance for misalignment.
3. Provision for lubrication, reserve lubricant and sealing.
4. Low unit bearing loads
5. Controllable bearing clearance with anti-rattling provision.
6. Easy to assemble, disassemble, and attach to arm or link.
7. Low cost.



The linkage joints pictured above are from:

1 Automation Bearings Corp
2 Carter Engineering Co
3 The Foxboro Co
4 The Heim Co
5 Sealmaster Bearing Div, Stephens-Adamson Mfg Co
6 Superior Ball Joint Corp
7. Thompson Products Inc, Michigan Div
8 J J Tourek Mfg Co
9 Westchester Technical Corp

The ideal linkage joint should be a ball-and-socket type in order to be self-aligning. It should need support on only one side to have interrelated advantages of fewer parts, lighter weight, easier assembly and lower cost. And it should be easily sealed. But how well should it meet other requirements? For example, how to handle the higher stress that a single-side support puts on the stud joint?

When the pivot and joint centerlines of a linkage arm are parallel and alignment presents no problem, a cylindrical joint can be used. When alignment is a problem, two cylindrical joints may be used with axes at right angles, or a combination of a cylindrical pivot and a ball joint.

But a ball joint mounted as a cantilever allows for high misalignment while keeping cost low, parts to a minimum and the assembly light in weight.

To design a linkage joint, certain specifications must be met regardless of whether the joint form is cylinder or ball-type. Based on specification

REPRINTED—circle E53, inside back cover

any number of different types of joints are possible—many are shown on these and next two pages. But the requirements of an ideal ball joint based on specification and previous know-how are many. They are listed in the accompanying table (p. 87). With this table as a guide, the approach to an ideal joint is simple and direct.

Linkages—the Why and How

Arms and links are nonwearing members of a linkage; they are shaped to carry external loads. Pivots and joints are wearing members. A joint is a bearing unit connecting an arm and a link. A pivot is a stationary bearing unit attached to an arm. An arm is connected to a pivot and a joint; a link connects two joints.

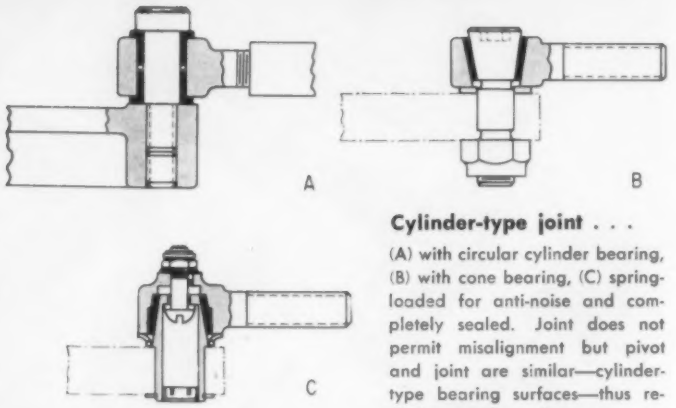
In a 4-bar linkage the moving paths of the two joints at ends of the link are determined by movements of the arms rotating about the pivots. Distance between the joints is fixed by the link length. In transmitting force from driving to driven arm, a joint is a bearing member that transfers the force between arm and link. Relative movement between these elements could be in a single or variable plane.

Joint design leads to the selection of a cylinder or ball-type. Cylinder-type is a bearing with a straight centerline about which the arm and link must rotate—causing both the joint and pivot of the arm to be parallel. If not, bearing surfaces will bind—causing friction, undesirable strain and fast bearing wear.

Ball joint has a common center between arm and link at a point in the center of the ball. Link can move in any direction with respect to the ball. Advantage: high permissible misalignment of pivots.

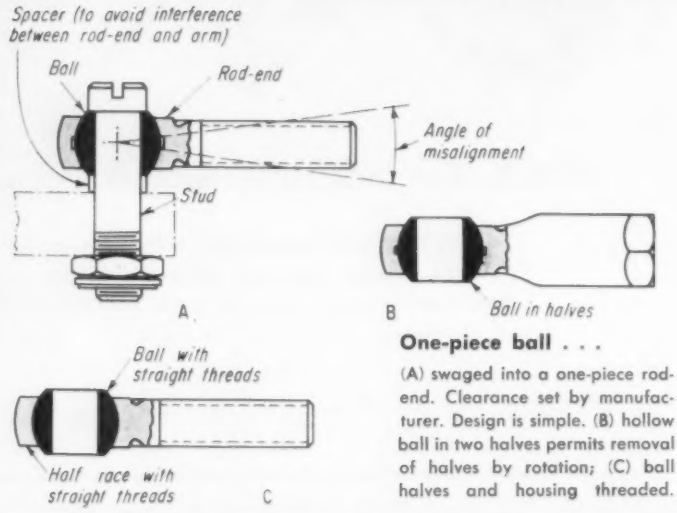
It is almost impossible in production to make every part to the same dimension. Tolerance must be allowed or cost of the part will be too high. Cylinder-type joints require high precision to maintain the necessary linkage parallelism. Therefore, they should be avoided for economical and efficient design.

Ball-type joints permit generous tolerances because parallelism is not needed for proper operation. Arms can be in any relative position and will function without excessive wear caused by binding. Also, no bending stress is imposed on the link, permitting a lighter weight link to transmit the



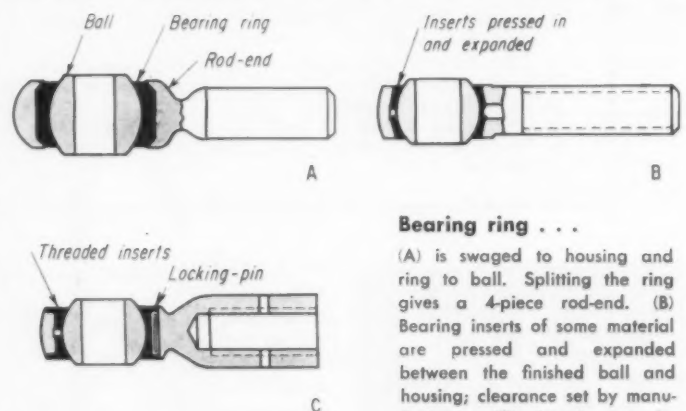
Cylinder-type joint . . .

(A) with circular cylinder bearing, (B) with cone bearing, (C) spring-loaded for anti-noise and completely sealed. Joint does not permit misalignment but pivot and joint are similar—cylinder-type bearing surfaces—thus reducing number of parts.



One-piece ball . . .

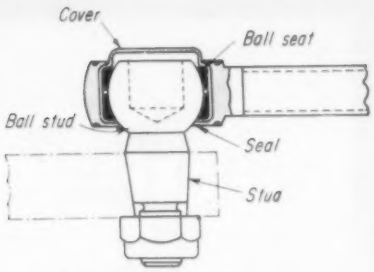
(A) swaged into a one-piece rod-end. Clearance set by manufacturer. Design is simple. (B) hollow ball in two halves permits removal of halves by rotation; (C) ball halves and housing threaded.



Bearing ring . . .

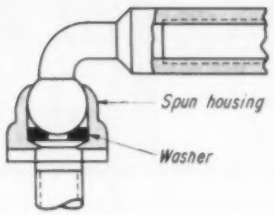
(A) is swaged to housing and ring to ball. Splitting the ring gives a 4-piece rod-end. (B) Bearing inserts of some material are pressed and expanded between the finished ball and housing; clearance set by manufacturer. (C) Inserts can be moved for wear take-up.

AVAILABLE LINKAGE JOINTS



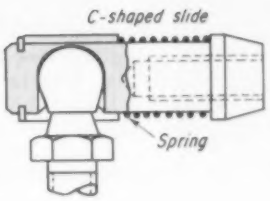
Ball integral with stud . . .

and a 2-piece ball seat staked into the rod-end. Cover and seal are optional features. Taper on stud gives largest dia where stresses caused by loading, are highest.



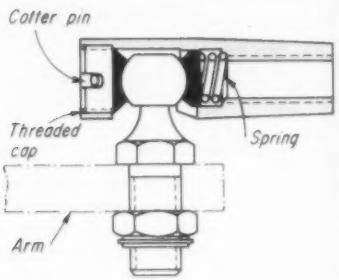
Ball integral with rod end . . .

retained by the spun housing and supported by the resonant washer. Washer cushions movement and maintains proper tension. No wear take-up adjustment possible.



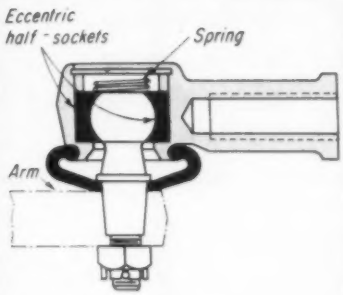
Specially shaped ball stud . . .

withstands higher transmission force by increasing stud-neck dia. Slide pushed against spring permits rapid disassembly. No provision for wear take-up or anti-rattling.



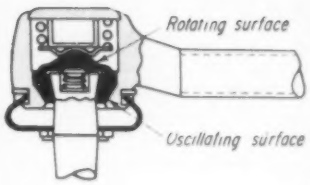
Threaded cap bearing . . .

is slotted and adjustable, to maintain a predetermined bearing force by the compression spring on the ball stud through the bearing seat. Wear take-up and anti-rattling are provided by the threaded cap.



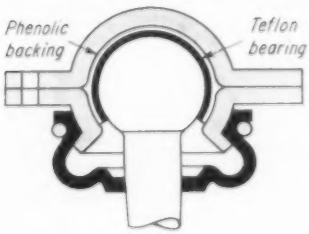
Steering linkage-joint . . .

for vehicles. Torsion spring forces two eccentric half sockets to tighten around the ball as wear occurs. Unit is sealed and enclosed and can be packed with lubricant or grease for maintenance-free application.



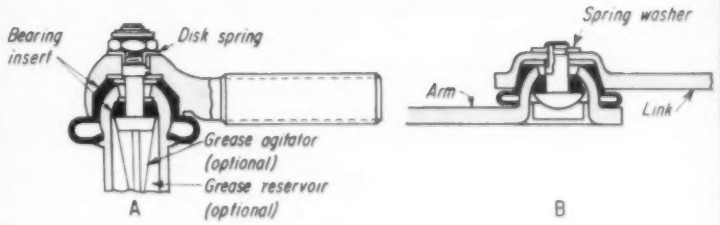
Vehicle joint . . .

for steering linkage. Note that the rotative bearing surface is separated from the oscillating bearing surface. Stud and ring ball can be one piece. Joint can be packed with lubricant or grease and then sealed.



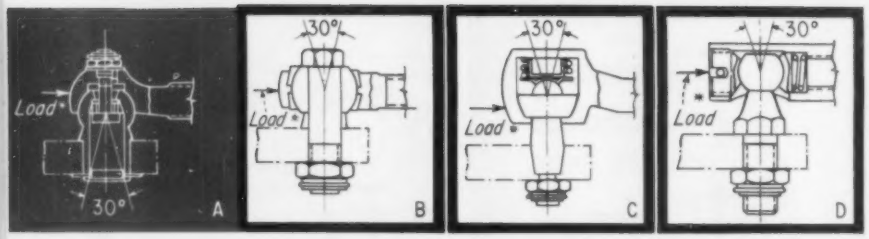
Front-wheel suspension . . .

for automobile. Kingpin not required. Thin layer of Teflon on a phenolic back reduces bearing friction. Ball is completely enclosed and sealed; can be grease-packed.



Coupling pin joins . . .

stud and housing (A). Clearance is set by nut on pin. Head rides on bearing ring which permits pin to float free in the stud. Grease agitator and fitting are optional. (B), Sheet metal arrangement using spring washer to hold coupling pin. Sealing is optional feature.



COMPARISON: Engineering Data on Four Ball-type Joints

	Main Bearing Area		Bearing Pressure		Stud Area		Combined Tensile Stress in Stud		Combined Shearing Stress in Stud		Max Rotation	
	in.²	%	psi	%	in.²	%	psi	%	psi	%	rpm	%
Sketch A	0.129	100	7,750	100	0.0859	100	44,300	100	23,700	100	47.8	100
Sketch B	0.195	151	5,130	66.3	0.111	129	85,500	193	43,200	182	51.7	108
Sketch C	0.135	105	7,410	95.2	0.101	118	97,200	220	49,100	207	37.8	79.1
Sketch D	0.069	53.5	145,000	187	0.111	129	129,000	291	62,500	264	26.3	54.9

* 1000-lb radial load and a *PV* value of 50,000.

tensile or compressive load.

In certain applications, arms must rotate 360° or oscillate over an angular range which causes the link to pass the shaft of the pivot. This requires single-side support; double-side support will also work, but at cost of increased weight and complex design.

A linkage joint normally consists of two basic components—stud and housing. Stud is attached to the arm; housing to the link. Depending on method of support—single or double-side—the stud will be stressed in single or double shear combined with bending in cantilever or double-support form under a radial load. Also, there will be either an axial tensile or compressive stress caused by the axial load on the stud. But the many advantages of the single-side-support joint far outweigh the obvious disadvantages of higher stress when compared with a double-support type equal in size and carrying an equal load.

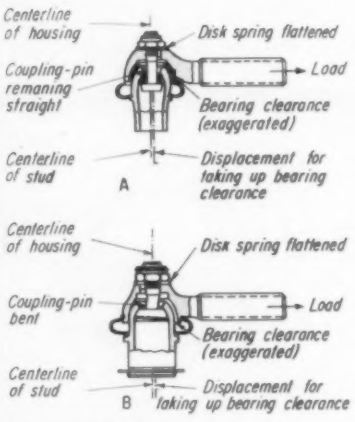
Toward the Ideal Linkage Joint

Basic requirements for the ideal linkage joint take into account the high stress normally imposed on the joint stud as well as ease of manufacture and the normal variations met in specification of materials. An exploded view of a joint aimed at meeting these requirements is shown on this page. Its advantages are:

- Bearing clearance between housing insert and the stud is controlled by turning the nut to limit total movement of the housing.
- Bearing-surface wear of housing insert and bearing ring can be compensated by further tightening the nut. Bearing clearance is maintained without dismantling or removing any part of the joint.
- Coupling-pin head can float free. This permits the pin to remain straight and loaded only in tension induced by any radial load on the joint. Bearing clearance causes centerlines of the pin and stud to be displaced when any radial load is imposed. The free-floating pin is not stressed when bending is perpendicular to its centerline and can, therefore, be designed for pure tensile stress only. A smaller-diameter pin can be used because it need only resist the axial load plus or minus about ⅓ of the radial load. Addition of a bending load requires a larger pin diameter.
- Plane bearing surfaces of the coupling-pin head and the bearing ring are under thrust load only, and will handle 360° rotational movement.

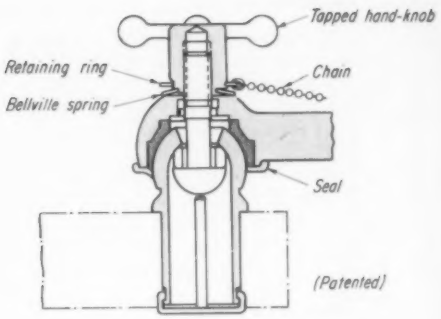
Exploded view . . .

shows component parts of approach to ideal linkage joint. Large-dia hollow stud reduces cantilever mounting stress. Bearing clearance and pre-load are controlled by coupling-pin nut. Various materials can be used and all parts easily fabricated or purchased.



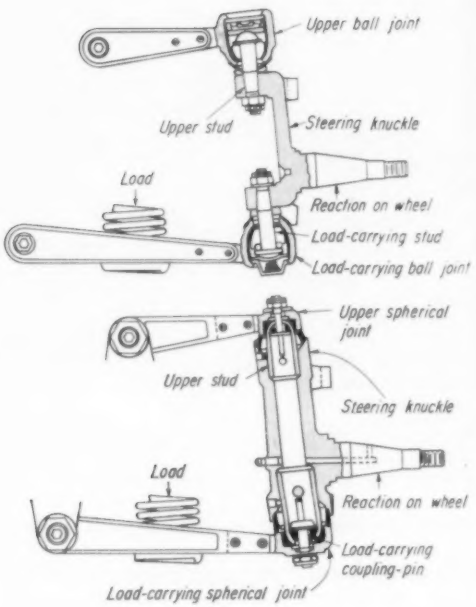
Loaded joints . . .

indicates bending in the coupling pin. Addition of bearing ring in (A) keeps pin straight reducing coupling pin size and the over-all size and weight of joint.



Trailer coupling . . .

using ideal joint arrangement. Vertical rod prevents coupling pin from dropping into stud upon accidental uncoupling. Coupling pin extends into hand-knob.



Automotive suspension system . . .

(Upper) replacing king-pin construction and threaded bushing. But studs are under tension, shear and bending. (Lower) improved design, using ideal joint arrangement, places only hollow stud under combined loading; coupling pin is subjected to tension only.

• Spherical bearing surface of the bearing ring and the inner spherical bearing of the stud are under thrust load only, and will take care of the tilting motion of the joint. Spherical bearing surface of bearing ring has very low rubbing speed and is always in oscillating motion.

• Combined stress induced in the stud by radial and axial load is comparatively small because of the inherent rigidity of its form. Cylindrical form means it will take a higher bending moment than a solid rod with the same cross-sectional area.

• Weight-saving comes from the smaller-dia coupling pin. Over-all space required is about equal.

Applications for Improved Joint

Fields of application include automotive, aircraft, machinery, instrument and others. For example:

Trailer coupling. A coupling for a trailer must be strong enough to avoid possibility of failure. It must also provide for a large angle of misalignment, easy assembly and disassembly with no chance of accidental disconnection and no loose parts when trailer is detached.

Ball suspension. Automotive manufacturers have converted the front suspension from king pin construction and threaded bushings to ball-type joints. These joints serve to prevent stiffness in the suspension and steering motion that resulted from misalignment in the threaded bushings.

Improved design permits a reduction in stress concentration at the studs, steering knuckle and suspension arms. Other general advantages include: fewer parts required, easier maintenance, wear is taken up, easy lubrication. Also, the design simplicity can be applied to developing a front-wheel drive—by adding a universal joint with its center in line with the centers of the upper and lower ball-type joint.

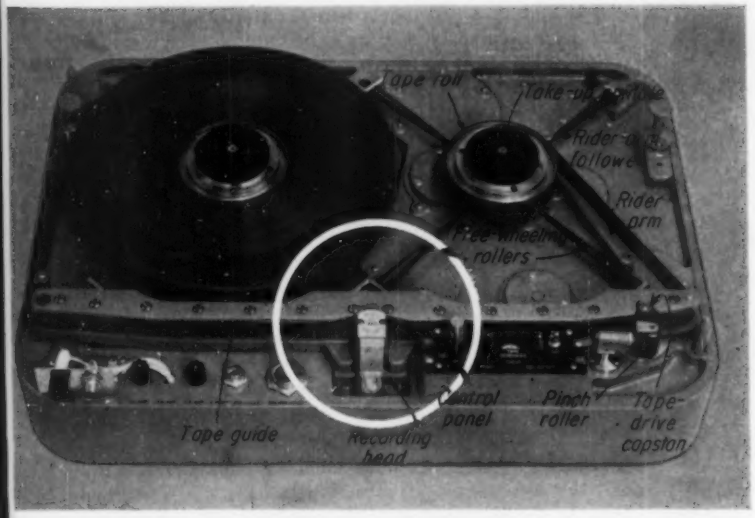
Other applications include automotive gear-shifting, throttle control, braking linkages, automatic packaging and processing machines, and linkages for computers, typewriters, electrical equipment and others.

REPRINT of this article can be obtained for your reference file by checking E53 on one of the Reader Service cards bound in this issue. For further reprints available see "Current Reprints" listing in this issue on page 159.

The author wishes to thank the following companies who supplied parts for the photograph on page 87 or for drawings and information about their linkage joint or rod-end fitting: Scott Browne Corp, Automation Bearings Corp, Carter Engineering Co, The Foxboro Co, The Heim Co, O & S Bearing & Mfg Co, Micromatic Hone Corp, Southwest Products Co, Sealmaster Bearing Div of Stephens-Anderson Mfg Co, Michigan Div of Thompson Products Inc, J J Tourek Mfg Co.

EDITOR'S NOTE: Linkage analysis, design, application, and selection is a broad and continuing subject of interest to machine designers. Here are some other helpful articles that have appeared in these pages.

Linkages, their design, analysis and application are discussed in: "Linkages Gain on Cams," Dec 23 '57, p 75; "Four-bar Linkages as Function Generators," Oct '56, p 166; "Linkage Layout by Mathematical Analysis," Aug '56, p 165; "Linkage Design Technique," Dec '54, p 133.



Needing no reel . . .

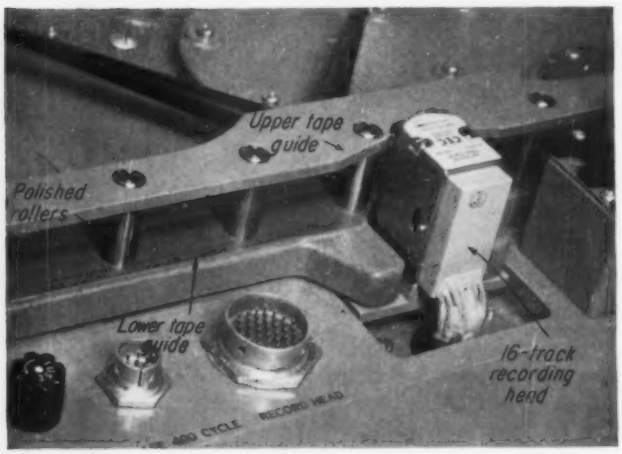
the 8400-ft roll of 1-mil tape is wound on flangeless hub; rests on and is centered by conical, freewheeling rollers. This eliminates several problems: friction at sides of a reel; the added mass needing acceleration; space wasted by the reel.

Taper of the rollers is such that surface speed is same at all points of tape contact. Duplicate set of rollers in lid (not shown) of recorder ride on top of tape roll. Normally there is 0.005-in. clearance between rollers and tape roll.

Tape skew . . .

or sideslip of tape passing 16-track recording head must be minimized if high-density data is to be accurately recorded. Long, bow-shaped guide has upper and lower surfaces ground flat to within 0.0005 in. over entire length and holds variations in distance between surfaces to 0.0002 in. Averaging effect of long tape guide reduces skew to 100 microin. Tape speed may be varied from 2.8 to 56 in. per sec.

Tape Recorder —many speeds but NO REEL



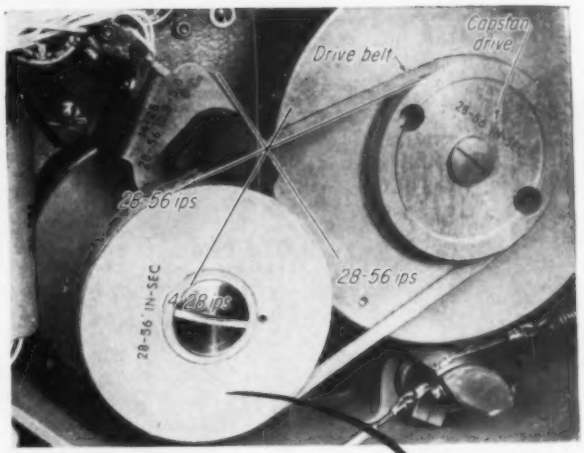
Over 16,000 bits of information per linear inch of tape are stored by this reel-less tape recorder. It is built around a complex casting that serves both as rigid component base and duct system for cooling.

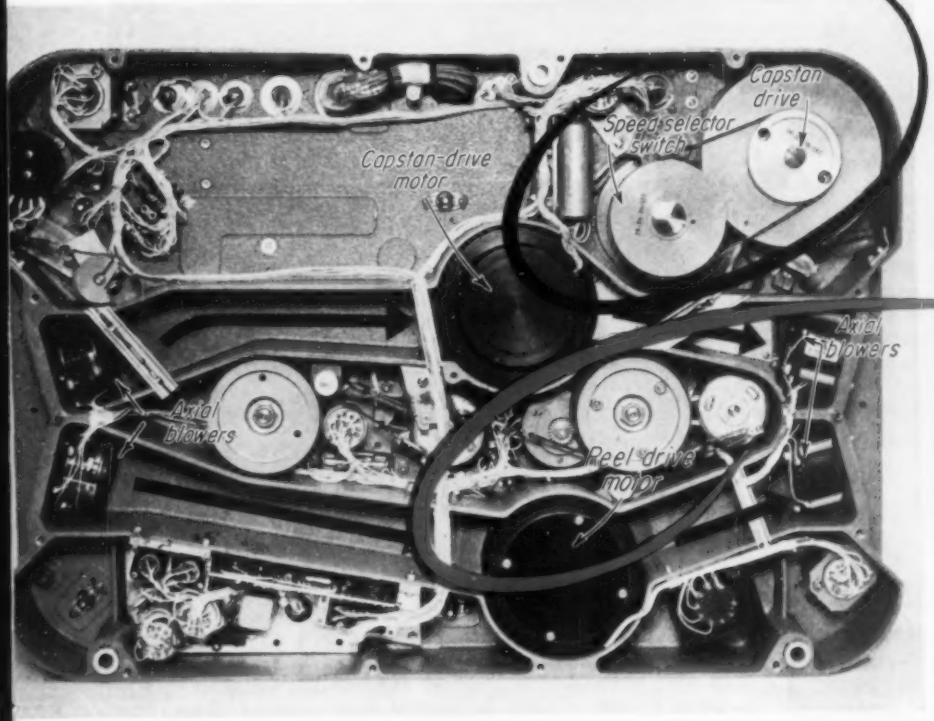
Designed specifically for flight testing the DC-8, the airborne recorder meets unusual design requirements for capacity, speed and accuracy. Tape removal is from the top; so is accessibility to all controls and connections—permitting drawer mounting. Unit has been subjected to 10-g vibration—without shock mounts—yet it continued to operate. Recorder is part of test system that reduces data-handling time, for a 10-sec structural maneuver performed by a medium bomber, from 237 to 58 manhours. System is produced by Datalab Div of Consolidated Electrodynamics Corp, Pasadena, Calif., under contract with the Douglas Aircraft Corp.

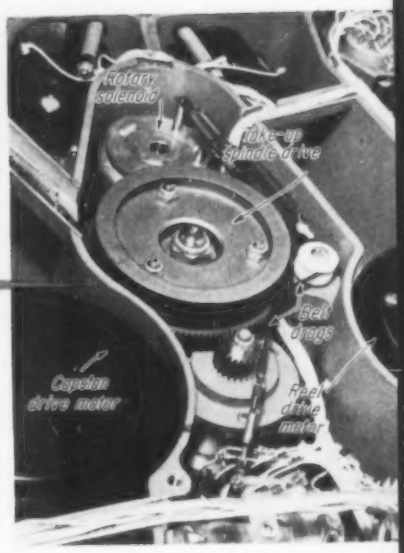
IN NEW PRODUCTS

Foolproof switch . . .

is incorporated in second-stage belt-drive reduction of capstan drive. This drive is interlocked with tachometer-feedback system by manually operated switch with slots in knob pointer. For given pulley setup, switch must be in correct position or drive belt cannot be installed. Conversely, correct pulley dia must be used for a given switch setting or drive belt will not match slots in switch knob. Lines show belt position for different drive speeds in in./sec; 3-position switch and 2-speed drive motor give operator choice of 6 tape speeds.







Hot spot . . .

caused by drive motors is cooled by push-pull setup of axial blowers. Casting webs are used to form ductwork to and from motor housings. In addition, aluminum chassis and case act as heat sink and aid heat dispersion. Cooling capacity of blowers is constant over fairly wide altitude range because motor speed—and weight of air delivered—is governed by density of air moved.

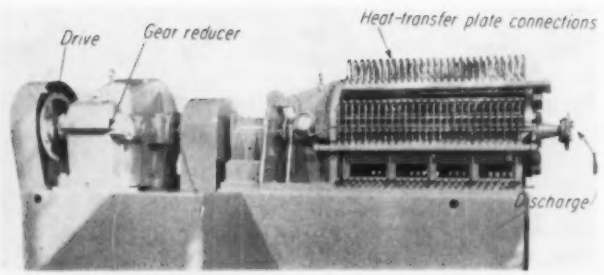
Belt drag . . .

on drum attached to take-up reel spindle is released during acceleration. When tape speed equals surface speed of capstan, pinch roller clamps moving tape to capstan. Relay that operates pinch roller solenoid also reduces current to reel motor and activates rotary solenoids to tighten belt drags. Rider arms on tape-rolls mechanically decrease spring tension of belt drags as take-up roll size increases, providing constant tension to the tape. Capstan drive is a two-speed (4000-8000 rpm), hysteresis-synchronous, constant torque, 208-v, 400-cycle, pancake-type motor.

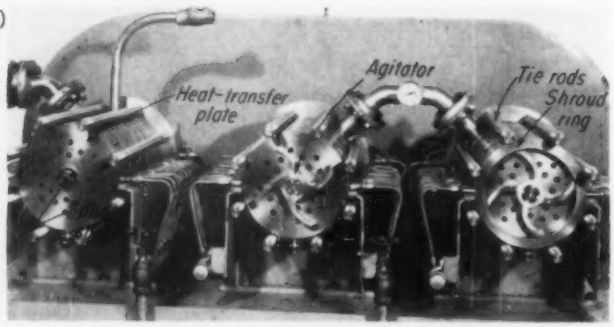
Stacking the Components Simplifies Assembly

It also eases cleaning of the continuous reactor shown at top, in which different combinations of standardized mixing and heat-transfer elements handle different process conditions.

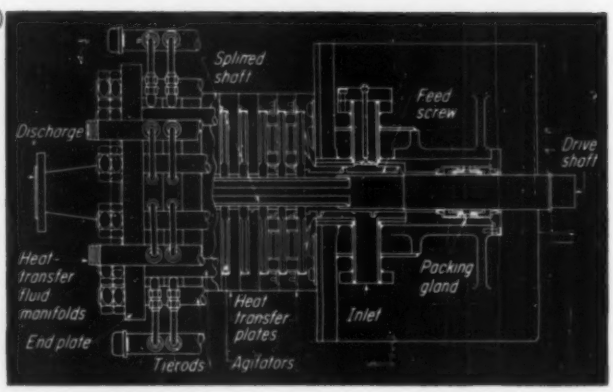
The unit is designed to handle a variety of mixing operations requiring precise temperature control. Several such reactors can be combined to operate in series or parallel to meet the needs of a specific process. Called the Continuous Flowmaster Reactor, the unit is produced by Baker Perkins Inc, Chemical Machinery Div, Saginaw, Mich.



(A)



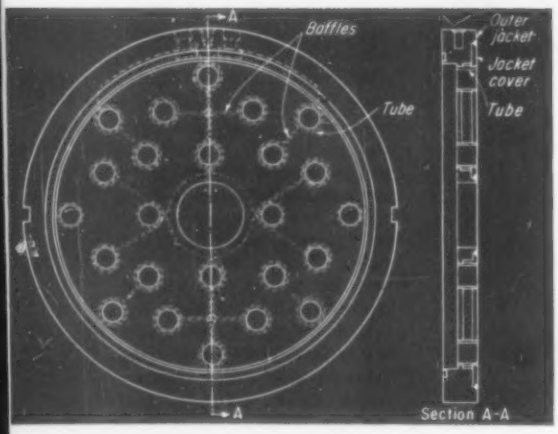
(B)



Basic components . . .

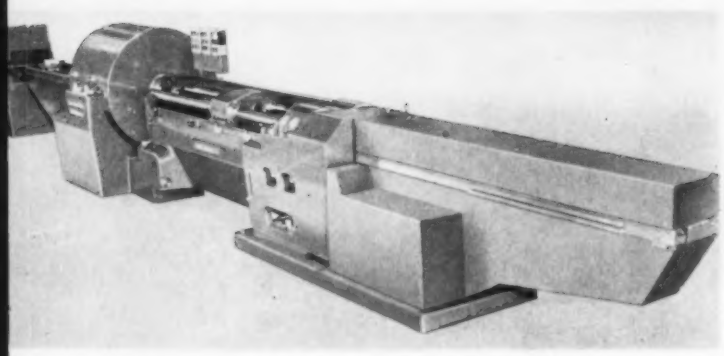
of the reactor are the stationary heat-transfer plates and rotating agitators (A). Stacked over the central splined shaft, plates and agitators are clamped together by tierods and end plates (B). Heat-transfer fluid is piped to the plates by manifolds and individual tubing. A separate pump is used to force the material being processed through the reactor. Only one packing gland is required for the drive shaft, simplifying cleaning and replacement.

High turbulence is achieved through having the agitators work on a small volume of material. This in turn gives a thin-film condition that provides excellent heat-transfer characteristics.



Hollow heat-transfer plates . . .

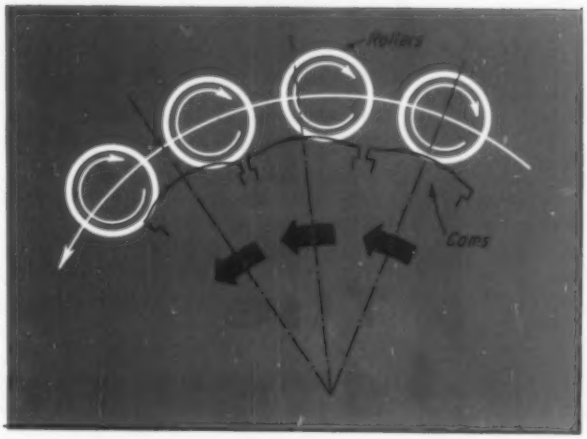
are constructed of an outer jacket and a jacket cover welded to it. The passage tubes go through the housing and cover, and are expanded to produce a 200 psi test joint. Cross flow of the heat-transfer fluid may be achieved by baffles mounted between the tubes.



Cams Drive Steel-squeezing Dies

Inexpensive mandrels profile the ID of cylindrical workpieces in cam-and-roller design for chipless machining.

In this cold-working method, pulsating squeeze of the dies has several advantages: no stock is wasted; hardness is improved and tensile strength increased by 15 to 50% depending on reduction in area; its fatigue life is improved because of continuous flow lines formed in the profile (above right) and the residual compression stresses given the surface area. "Intraform" is produced by Meta-Dynamics Div of Cincinnati Milling Machine Co, Cincinnati.

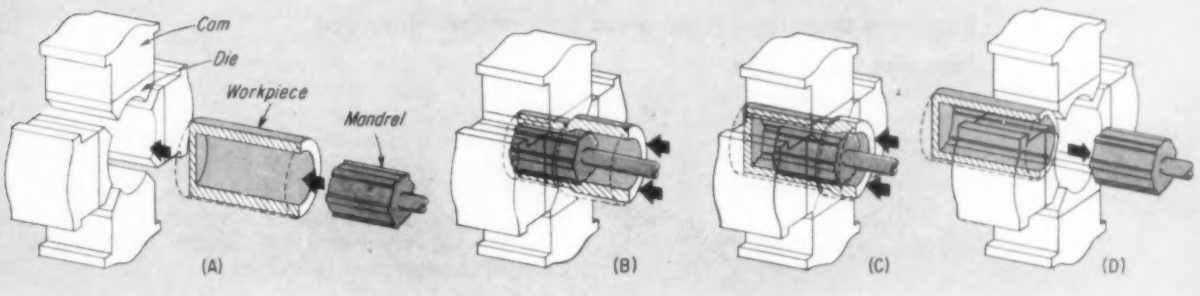


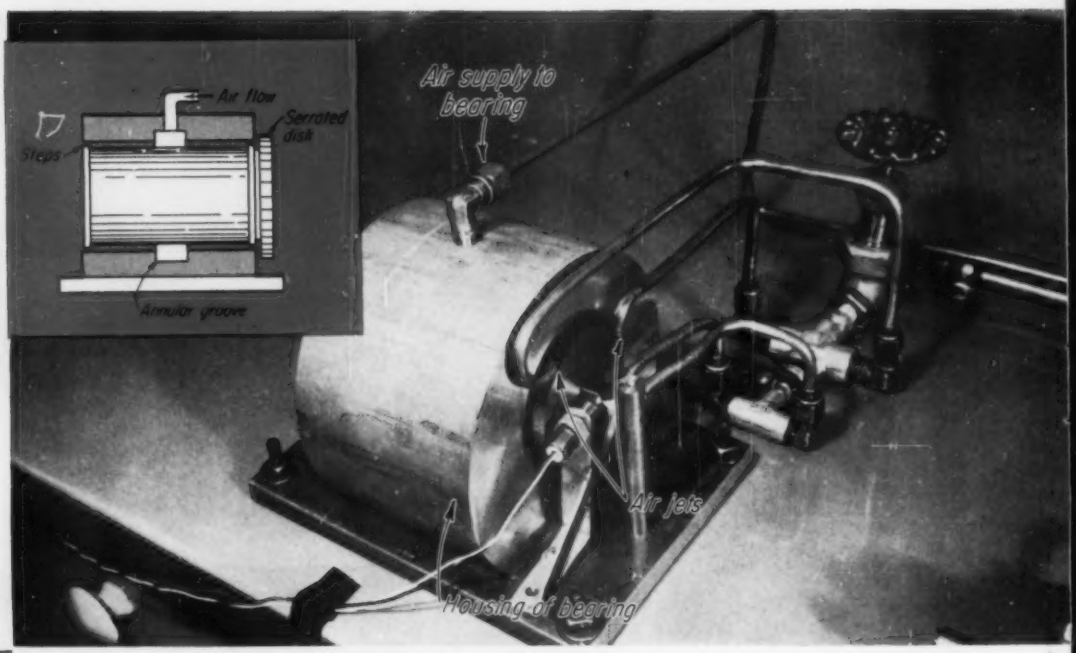
Mounted on cams . . .

the dies are pulsated by a series of freewheeling rollers located in a raceway in the machine's headstock. Never losing contact, the cams pass from roller to roller to produce the pulsating action. Sinusoidal form of the cam produces a smooth action—squeezing the steel workpiece more than 1500 times per minute.

Operational sequence . . .

begins (A) by placing workpiece over the mandrel and inserting it into open dies. Forming starts (B) as dies rotate. Contact with dies causes freewheeling workpiece and mandrel to rotate at 80% of die rpm. Forming continues (C) as workpiece is fed through die and mandrel is held between dies. Operation completed (D), mandrel is retracted and new workpiece ejects completed part into discharge chute.





TEST SETUP of radial step bearing, driven by air up to 100,000 rpm. Detail sketch shows simplicity of design. Shaft is driven here by air jets playing on serrated disk.

The STEP BEARING...

a new concept in air lubrication

Consisting of only two parts, bearings like the one above are rugged and inexpensive. They can be operated with air, gas, water or mercury—at high or low temperatures and speeds. The man who developed them gives performance data ond formulas for design.

CLARENCE R ADAMS
Research Engineer, Boeing Airplane Co, Seattle, Wash.

A new type of hydrostatic air bearing has been developed and designed at Boeing to conquer the instability and manufacturing problems common with older air bearings. The new unit is easily produced and has extremely low friction characteristics. Above certain speeds, it operates hydrodynamically as well as hydrostatically—hydrostatic operation is made possible by machining-in small steps to confine and direct the air flow that floats a rotating shaft; the hydrodynamic operation is caused by the close tolerances used in the design.

Hydrodynamic or Hydrostatic

Air bearings (or gas bearings—the two terms are used interchangeably) are classified as either hydrodynamic or hydrostatic.

In hydrodynamic, rotation causes a pressure buildup because the air, which adheres to the shaft, is pulled into the converging space between shaft and housing. Such bearings have a limited load-carrying ability—at low speeds it is practically zero. But this has compensations—no power loss from an external pressure source.

Hydrostatic bearings, on the other hand, depend on air pumped in under pressure to form a lubrication film that supports the shaft. The air is supplied through fixed orifices and allowed to escape through the clearance between bearing and shaft.

In both cases, the shaft is seldom concentric within the bearing. Under load, the shaft restricts air flow below it causing the pressure to rise; the resulting counterforce sends the shaft upward. So, with clearance always changing, the bearing is prone toward instability—slight vibrations on the shaft can cause it to rotate in eccentric fashion.

Difficulty with Orifice Type

Conventional hydrostatic air bearings have this in common—they feed air (or gas) through orifices equally spaced around circumference of the shaft. Design may include pressure islands or pockets which prevent orifices from being smeared shut during inadvertent rubbing, and can increase load-carrying ability. But they cause bearing instability if improperly designed.

Their volume must be kept to a minimum and they should all be equal and symmetrical. A simple way to assure equal volumes is to use cylindrical pockets made by drilling and plugging the bearing to a desired depth, or give the bearing an inner sleeve with predrilled pockets.

Size and number of the orifices influences load-carrying capacity. It is difficult to select a size that will not easily clog and which can be readily produced with accuracy. Size also influences machining accuracy and alignment requirements, bearing clearances, number of orifices, gas flow and filtering requirements. Stacking a number of large-dia orifices to obtain the desired flow restriction may be practical in some applications. Larger orifices clog less and can be produced with more ac-

WHY AIR BEARINGS?

The interest in air bearings centers around their four major lubricating advantages; very low friction resistance; ability to operate at high temperatures, and at high speeds; noncontaminating qualities.

High temperatures are no problem . . .
Oil or grease lubrication systems call for thermally stable lubricants and high-temperature seals when temperatures soar. By contrast, air lubricants do not break down at high temperatures and have less stringent sealing requirements.

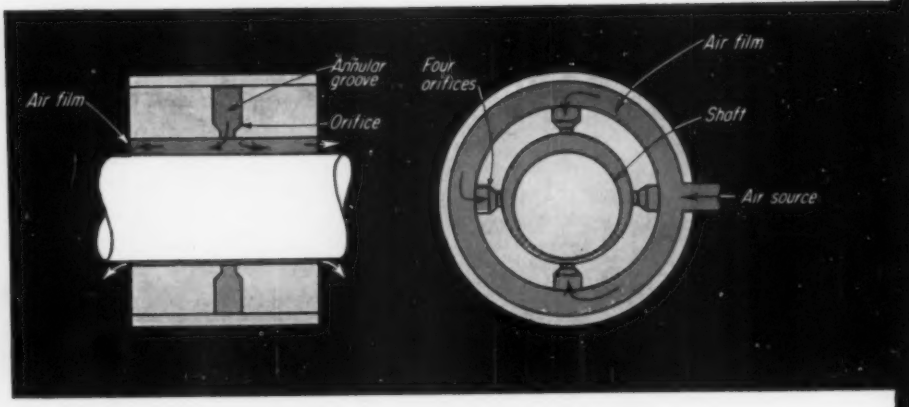
Shaft stiffness can be maintained . . .
At high temperatures a larger shaft diameter will compensate for loss of material strength. With air bearings, the increased diameter is no disadvantage—in fact, it increases the load-carrying ability if air pressure is low.

Thermal expansion effects are minimized . . .
This is because both parts of the bearing can be made of materials having the same coefficient of thermal expansion.

WHERE STEP BEARINGS ARE BETTER

- **High-temperature electric motor bearings.** Step bearings can start hydrostatically, then operate hydrodynamically. Also, the step type assures better temperature distribution.
- **High-speed turbine drives** where high temperature or low friction requirements occur.
- **Nuclear applications** where lubricants would be affected by radiation. Step bearings have been operated with gas, water, and mercury as the supporting fluid.
- **Food processing** where bearing-oil leakage might contaminate the food. Step bearings, using pressurized water or air, would give no such problem.
- **Paper industry.** Step bearings, with water in place of oil- or grease-lubricated bearings could prevent pulp spoilage when bearing seals fail.
- **Machine-tool industry**—for high-speed grinders and other such applications.

Conventional hydrostatic bearings . . .
send lubricating air through orifices to surface of shaft. When shaft drops to position illustrated, a buildup of pressure acts to restore shaft to center.



curacy; but stacking them for high-temperature applications is difficult.

Step Bearings—a New Development

Research for a new type began in 1956 when Boeing needed air bearings that could operate at high speeds and temperatures—and possibly in a radiation atmosphere. The goal was a simple, rugged bearing with low air consumption—to minimize the chances of operational failure in aircraft and missile equipment.

Result, early this year, was the step bearing developed by the author. In the simplest type, for radial loads only, tiny steps—sometimes no more than 0.00025 in. high and 0.040 in. wide—are machined at both ends of the housing. The steps have a twofold purpose: They allow space for air below the shaft when it is stationary or about to start up; and they restrict air flow through the bearing to produce a pressure buildup that floats the shaft properly. An annular groove in the housing acts as a manifold to supply air completely around the clearance between housing and shaft.

This principle was also applied to combination radial-and-thrust bearings. In this type, a second set of machined steps, in combination with a flange at each end of the shaft, permits the bearing to take thrust loads.

To prevent galling, the steps and mating surfaces are flame-plated with tungsten carbide—a fairly inexpensive but effective process.

Step bearings were found to have definite advantages over multiple-orifice bearings. For example:

- Simple to produce—the annular grooves are put in by standard grinding equipment. Concentricity and parallelism must be maintained during grinding but this is less difficult than drilling tiny precise holes for air passages. Precision is comparable to that required in ABEC-7 bearings.
- Can take shock better—the steps are not as easily damaged as are drilled holes by momentary metal-to-metal contact when the bearings are subjected to shock loads or external vibration.
- Less affected by changes in air supply—testing with gas pressures from 0 to 2000 psi gave no chatter. This is because at higher speeds the bearings operate hydrodynamically—with little dependence on the pressurized air supply.

Data on Performance

Step bearings have been built in shaft sizes ranging from 0.500 in. to 3.125 in. dia. There is no reason why there should be any limit to size.

Bearings with 0.625-in. shafts have been run at speeds to 100,000 rpm with no ill effects. The 3.125-in. bearing has only been operated at speeds up to 24,000 because of limitations on the driving turbine. A new turbine is being installed which will make it possible to test the bearing at higher speeds.

Ambient temperatures up to 600 F have caused no problems. It is anticipated the bearing will work successfully at temperatures up to 1000 F.

DESIGN COMPUTATIONS

Some dimensions are suggested in the illustration on the following page. Others can be computed from these relationships:

$$L/D_3 \approx 1/2$$

C $\approx$ 0.0005 in., assuming no net change from thermal expansion or centrifugal force. If C is greater than 0.0005, then B/D_3 should be greater than $\frac{1}{2}$; however, B/D_3 should not exceed 1.1.

A should not be less than 0.040

$$A/B \approx 1/6$$
$$D_2 = D_3 + 2C$$
$$D_4 = D_3 + 0.2$$
$$D_5 = D_3 + C$$

Mathematical methods for calculating the load-carrying ability of the step bearings are not yet available. For development purposes, the bearing load is estimated, multiplied by 10, and set equal to the projected bearing area multiplied by the available supply pressure. Thus

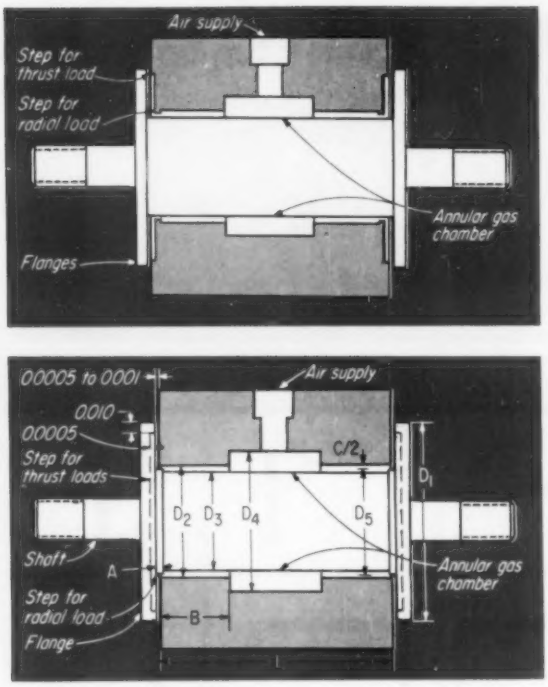
$$10W = 2LDP$$

and

$$P = \frac{5W}{LD}$$

where P = supply pressure, psi; W = estimated load on bearing, lb; L = bearing length, in.; D = bearing diameter D_3, in.

As an example, in designing the 3.125-in. bearing which had a length of 1.5 in., air pressure to carry the



Both step bearings . . .
are for combination radial-and-thrust loads. Design at top has both steps in housing—one for thrust, the second for radial loads. Lower design has both steps in flange. Flanges, unnecessary if only radial loads exist, are pressed on to shaft and pinned after assembly.

load (10 lb) worked out to be:

$$P = \frac{(5)\ (10)}{(1.5)\ (3.125)} = 11.9 \text{ psi}$$

Tests then showed the shaft floated freely with 9-psig pressure. This supply pressure can be reduced when the shaft builds up speed, developing hydrodynamic lift.

In fact, above 5000 rpm the 10-lb, 3.125-in. shaft will completely support itself hydrodynamically, and air pressure can be completely shut off.

Tests also indicate that a certain amount of instability caused by whirl can be tolerated. A 0.635-in.-dia step bearing shaft was operated at speeds between 20,000 to 51,000 rpm for 15 minutes with electrical continuity to determine the effect of rubbing. Although shaft and housing were both made from mild steel the only detrimental effect observed was a slight blueing of the shaft and housing at the step. An orifice-type bearing of similar materials seized immediately after electrical continuity was established.

OPERATING CONSIDERATIONS

The step type need not be kept as clean as other air-lubricated bearings because the annular clearance circling the shaft is big enough to allow passage of dust and other contaminants.

Critical shaft speeds, external vibration and shock loads may cause the shaft to momentarily break through the pressure film. Galling between shaft and bearing can be prevented by using appropriate bearing and shaft materials or with dry-film coatings. Best low-cost material combination to date is 4130 steel shaft in a 24ST aluminum housing. The step bearing operates under an unbalanced load because contact area of the step is small. Galling is localized and does not cause complete seizure when there is intermittent rubbing.

Equipment should be capable of starting without a time delay for pressure buildup in the bearings. Here, dry-lubed, hardened surfaces may be adequate for starting and also stopping without air lubrication (but lack the heat-dissipation ability needed for sustained operation at high surface speeds). Pressurizing the bearings before a start may be practical in some applications. For the sake of simplicity, bearing pressurization should coincide with starting. Stopping an unloaded machine while the bearings are pressurized will require special consideration because of low bearing friction. An electric motor, converted to air bearings, coasted for 25 minutes after the power was turned off.

When air supply and electric power were cut off simultaneously, the bearing and shaft were slightly galled but not enough to prevent repeated operation. However, special shaft and bearing treatment will be needed for satisfactory high-speed shutdowns after loss of pressure. Braking forces may be useful in some applications to stop rotation before the gas supply stops.

Seal requirements for air bearings are almost negligible. In turbine-drive applications, the machine can be designed so that exhaust air from the bearings is carried away with the turbine exhaust. It may be practical in low-hp turbine drives to have air flow from the bearings help drive the wheel. If the lubricating air must be prevented from contaminating other parts of the machine, labyrinth seals with a bleed port between lands are quite effective. Design considerations should include the cost of providing a pressurized air or gas supply. A system study must still be made to determine the factors affecting cost.

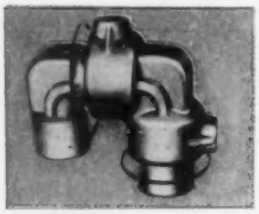
AIR SUPPLY IN AIRCRAFT

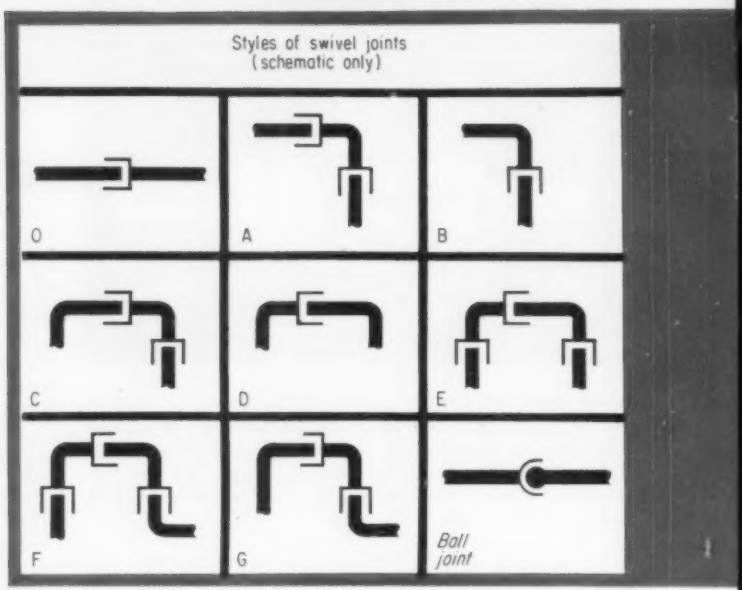
One source of pressure for such bearings in aircraft accessory equipment is engine-bleed air. During a typical flight there would be times when this pressure is low. The bearing should be designed for low pressure operation, or bleed pressure could be boosted by a turbo-compressor.

Some rocket-propelled vehicles use the generated gases to drive auxiliary turbines. The gases can be first shunted through the bearings before exhausting directly into the turbine nozzles. A compact, short-life unit could be built with the air generator built into the hollow shaft of a turbine drive.

EDITOR'S NOTE: Intense interest in air bearings has prompted eleven government agencies to support a research program at Franklin Institute to develop design technology. For details, see "Lubricating With Air," Nov 25 '57, p 99. This special report also contains practical charts and equations for designing hydrodynamic air bearings.

fewer wrong guesses when...





When the pipe connection isn't hose but has to turn in different directions—especially when it's a 3-D affair—final design becomes answer to a puzzle. Here's a straightforward basic approach that will eliminate much of the trial and error.

G M Bagnard, *Chief Engineer*
Chiksan Company, Brea, Calif.

The problem of choosing swivel joints for a fairly complicated piping system need not be as difficult as it looks at first. True, thinking in three dimensions is usually required before you can hit on the combination of swivels and pipe that will do the job at lowest cost—and without the built-in errors of judgment that result in mismated flanges, jammed assemblies or more joints than actually needed. But three basic techniques are given below to determine the best configuration of piping—and they work for 3-dimensional as well as 1- and 2-dimensional problems.

Of course, some compromise will be necessary. For example, it may not be possible to have simultaneously the minimum number of joints and the shortest total length of piping. And there may be specific problems and limitations that will affect design. It will be necessary to determine in advance whether space will be tight or loose, maintenance easy or difficult, obstructions present or absent, and loading on supports excessive or negligible.

Each of these problems will have to be considered separately. This explains why successive revisions of the original design can not only be expected but will be a necessary part of the design procedure.

Three Ways to Plan Joints

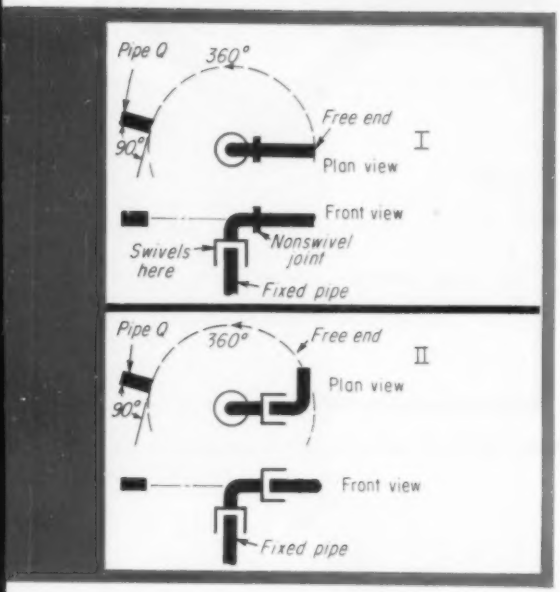
Despite a certain amount of trial-and-error needed to arrive at the final design, work all along the way will be reduced by following the three basics.

Method 1—Models. A scale model of the proposed installation will usually save design time. With this way, also, points at which the assembly will lock can be readily determined in advance—thereby simplifying the necessary changes. But models can be expensive—or not available.

Method 2—Plan View. A simplified procedure without need for models is made possible by determining, in a series of views, what motion is required about each fixed point. Starting with the plan view, examine each critical point in a separate view that shows true lengths of the sections of the assembly required to move to that point. Then connect sections of pipe and swivel joints to provide the flexibility required in each view.

 REPRINTED—circle E52, inside back cover

DESIGNING WITH SWIVEL JOINTS



Plan views help avoid . . .
impractical connections. Scheme I using style "B" joint does allow simple connection at free end to pipe Q; but scheme II does not—an additional style "C" joint, at the end, would be needed to overcome angularity.

. . . AND MORE ABOUT THE SWIVELS

The flexible connection you choose need not necessarily be swivel joints—pipefittings with bearings. As the author pointed out in his previous article (*PE—Aug 4, p 40*), metal hose or rubber hose also have advantages, and his discussion of the swivels weighed what the other two types can offer when you consider such factors as temperature, pressure, flexibility, type of fluid, fluid friction, leakage, moments and forces. That article also cited nine previous ones that covered such subjects as rotating seals and joints, flexible hose, quick-disconnects, calculation procedures to compute pressure drop and hp in valves, piping and fittings.

Mr. Bagnard's present article assumes that the reader is choosing swivels—for such reasons as greater mechanical strength or pressure capability. But his advice will also help design with any other flexible connections.

In a coming issue the same author will carry his guidance still further with graphs covering frictional torque vs nominal pipe diameter, and fluid pressure drop vs fitting size.

Method 3—Three Planes. A more rigorous approach—usually best for very difficult 3-D connections—is to select three mutually perpendicular planes, and examine all motions in each. An assembly of joints can then be established to give desired movement in each plane. The designs may be modified afterwards if corrections or special conditions are required. In this method, it is often necessary to lay out several auxiliary views to get the exact dimensions of the various sections of the assembly.

Direction of Movement

Most of the normal flexibility problems can be solved by Method 2. Inasmuch as the same reasoning applies to all three methods, let us examine the second method's simplified procedure:

At each swivelling connection start with the one fixed point about which the mating lines must move. If both ends move, one line should be considered stationary, and the other line mobile in relation to the stationary line.

Next step is to determine the path that the moving end of the line is to follow. The maximum and minimum distances it must travel are very important. Line length should allow parts of the assembly to move to all required locations without mechanical interference. If the line must move in at least two planes, the critical points in each plane must be determined.

Radial position of the line is important. The pair of sketches on this page show two different fittings that give the same rotation (a full 360°) cannot be given the same hookup at the free end because of difference in offset—therefore radial position—in each fitting.

The Torque Requirement

At increased fluid pressure, the joint packing makes a tighter fit and bearings also get increased loading. The torque required to turn the swivel becomes greater, and must be evaluated in advance: to compute force needed at end of the pipe to swing the joint, and to compute forces imposed on the rigid lines.

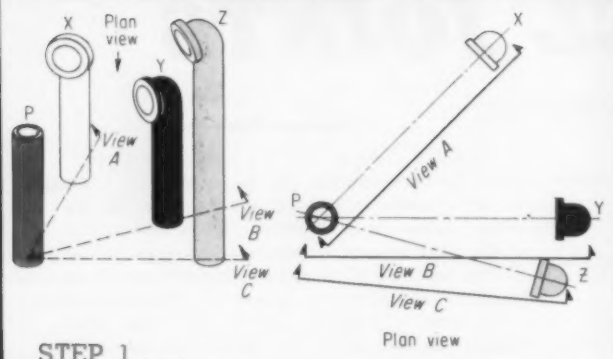
These factors must be considered in determining the allowable torque: Will the line be moved by hand, by equipment motion, or by some special actuator designed for the purpose? How much effect will weight of the completed assembly have on the total torque developed?

Torque and related forces must sometimes be controlled or limited by modifying the piping design. For example, the force needed to overcome swivel friction

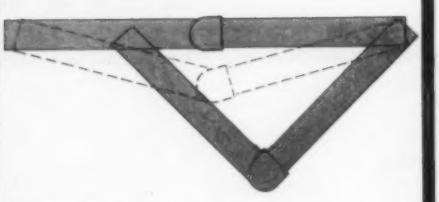
DESIGNING WITH SWIVELS–an example

This simple 3-dimensional design is a typical problem that can be solved with Method 2—the plan-view approach. Pipe *P* is a feed line that must be able to pass fluid to any one of three receiving pipes, X, Y or Z.

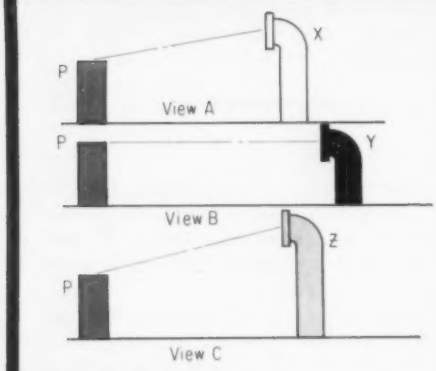
Choice is a single, flexible-line connection to serve the three pipes. It is less expensive than the alternative—valves and manifolds. Steel pipe with swivel joints will suit this hypothetical application best.



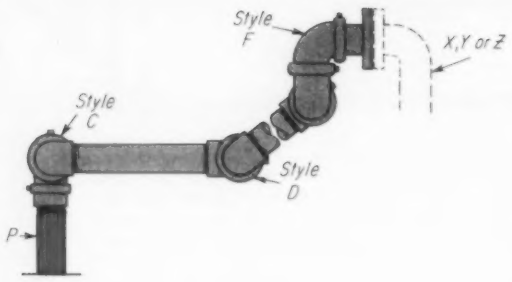
STEP 1 . . .
Plan view shows that rotational movement about point at top end of pipe *P* in a plane perpendicular to its centerline is required. This calls for attaching a style "A", "B", "C" or "F" swivel joint. The style chosen depends on motion required in other planes.



STEP 3 . . .
A variable-length connection is given by this swiveled "dog leg" that can have a style "C", "D", or "E" plane swivel. Choice depends on two related problems: flexibility required, and style of plane swivel selected at point *P* in Step 1.



STEP 2 . . .
Three auxiliary views are then developed in planes perpendicular to the flanges on pipes *X*, *Y*, and *Z*. Distances between top of *P* and each of the three pipes are different, and a variable-length connection is needed.



STEP 4 . . .
Selection of end fittings requires care because choice of conter joint will be affected. Style "C" swivel is the best selection at *P*. A style "E" would have more flexibility than needed and be too expensive for the job (it costs $30 more than style "C" in 4-in. size); and a style "D" has too few degrees of freedom. Style "D" is suggested for center of dog leg, and style "F" can be attached to opposite end of the dog leg to allow rotation of the flange to match bolt holes.

can be reduced by lengthening a section of pipe–therefore improving the moment arm. Furthermore, design of an assembly must sometimes be altered to avoid torques that tend to unscrew pipefittings. Counterweights can solve still another problem–that of unbalance caused by overhanging of piping.

The Cost

Costs can be evaluated for any given application, but it is not possible to establish a general rule. In some designs a single joint with two or more swivels will be cheaper than separate single-swivel joints for the same job. In general, the design with fewest interconnections will cost the least and have the lowest pressure losses. But flexibility and safety also frequently decide the issue.

REPRINT of this article can be obtained for your reference file by checking No. E52 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 159.

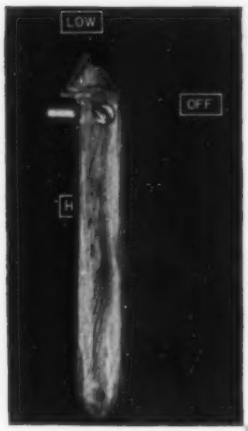
Designing the hardware that goes behind the control panel is the engineer's job—so much so that the controls on the front are often neglected. The machine will be easier to operate if you keep these tips in mind.

when choosing

SELECTOR-SWITCH KNOBS

GEORGE A PETERS

Psychological Research Associates Inc



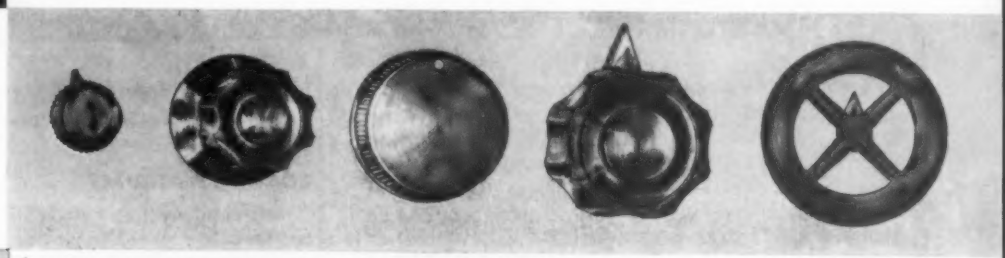
DON'T DO THIS . . .

What position is this switch in?—a puzzle because several basic principles of human-factors engineering are violated:

—The pointer, not the handle, should indicate switch position. A long, inexpensive, sheet metal pointer is better than trying to cast a suitable pointer on the handle.
—Don't place labels where they might be hidden.
—Don't locate switch positions 180° from each other.
—Scale should be marked from "low" to "high" in clockwise direction.
—Whenever possible, switch positions should be arranged in semicircle above knob.

OR THIS . . .

Chief objection to these knobs—they are round, (a shape that should be reserved for precise control of continuously variable functions). Also, pointer is hard to see; may be hidden by some other portion of the knob; may offer less contrast after wear and tear of continued use.

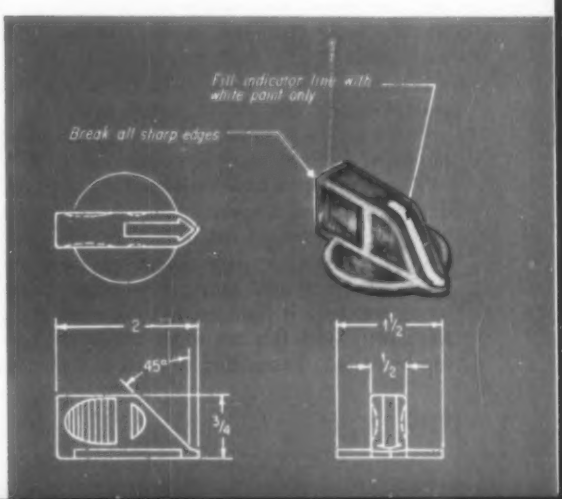


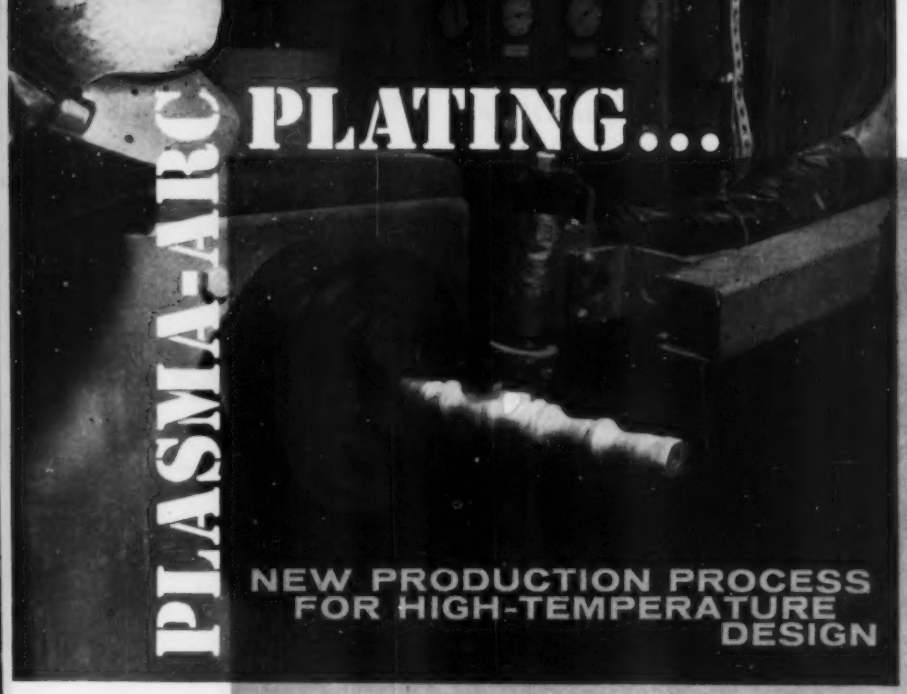
CROSSBREEDS AND COMPROMISES . . .

are an improvement, but such shapes are still not entirely functional. Straight-sided bar opposite pointer on knob (A) improves both blind positioning and reading accuracy but retains many of the limitations of round knobs. Knob (B) is a distinct improvement, but triangular shape can cause some confusion as to which acute angle is the pointer.

MOST READABLE . . .

and also most easily positioned, this knob has parallel sides and arrow that can be seen clearly—even at 45° below centerline. Panel guard is large enough to keep fingers out from between knob and panel, but not so large it obscures pointer. Arrowhead lies close to panel to thwart parallax errors. Large knob has concave sides with serrations so that it can be turned against 12 to 48 in.-oz of resistance without slipping—even while wearing gloves. Although switch positions should be kept to a minimum, selector switches should not be used for 2-position controls—toggle switches and push buttons are more positive, easier to operate.





PLASMA-ARC PLATING...

NEW PRODUCTION PROCESS FOR HIGH-TEMPERATURE DESIGN

With working temperatures of 20,000 F-plus, the plasma-arc torch can melt any metal or ceramic you want to deposit, and has gone to work shaping production parts from balky materials like tungsten and molybdenum. Here are first data on coating properties and design parameters—plus a look at things to come.

R D STACKHOUSE, A E GUIDOTTI *and* D M YENNI *Linde Company, Div of UCC*

A new metalworking process has been devised for the design engineer. It's the plasma-arc torch method for making coatings and shapes from ultrahigh melting-point materials. Simplicity of the method is shown in the photo above, where a plasma torch is applying a coating of tungsten to an assembly of mandrels which will end up as four rocket nozzles.

An outgrowth of research in arc physics, the method produces a high-velocity inert gas stream that can be kept at temperatures above 20,000 F for periods well over one hour. This means any material that can be melted without decomposing can be deposited on a surface.

The ability to melt refractory materials like tungsten and molybdenum, then deposit them as very dense, high-purity coatings on a variety of substrates, opens a new manufacturing technique for these normally difficult-to-work materials. By depositing them on a brass mandrel machined to a desired shape—a rocket nozzle liner, for example—parts can be completed by leaching out the mandrel with a suitable acid. This gives intricate structures that could be made in no other way.

To contain such high-temperature gas streams for production purposes, a special plasma-arc torch (for how it works, see next page) has been developed—with cooling built-in to keep the high-current arc from melting the torch. Sprays of cold carbon dioxide gas, played on the workpiece, keep it from overheating while the coating is laid down. With this new torch, almost any base material can be coated. In addition to brass and aluminum, coatings have been deposited on graphite, steel, molybdenum, aluminum, and certain reinforced plastics—particularly phenolics.

COATING MATERIALS

Ten basic coating materials have been established so far: tantalum, palladium, platinum, molybdenum, tungsten, alumina, zirconium diboride, and three combinations of tungsten with additives to improve its properties. These additives are zirconia, chromium, and alumina. Emphasis on property determination for these coatings has been placed on metallurgical structure, density, thermal shock resistance and mechanical properties. Rupture strength and elastic modulus values, determined from diametrally loaded split rings, are summarized in the accompanying table for the three coatings most widely investigated to date. Repeated tests on these materials, even though they are still in the developmental stage, show excellent consistency.

Furnace-treatment at 2550 F in an argon-hydrogen atmosphere increases coating density even closer to the theoretical maximum, and increases both rupture strength and modulus substantially. Although annealed values are so far available only on the pure tungsten deposit, theoretical considerations indicate coatings with additives should show substantial gain over the pure product. Further, the oxide additives improve oxidation resistance as well as thermal stress resistance. This latter effect comes from raising the ratio of rupture modulus-to-elastic modu-

lus. The amount of sudden temperature change a structure can withstand without yielding can be expressed in terms of this ratio—so, for a given class of materials, the higher this value, the better the thermal shock resistance. As an example, tungsten with some zirconia added has a ratio of 2.76—and has shown excellent service as a coating on graphite rocket engine parts.

DESIGN REQUIREMENTS

Although the process is still new, certain ground rules have already been established for design:

• **Shape of the part** or mandrel is limited to a surface of

(text continued on next page)

PLASMA-ARC TORCH COATINGS COMPARED

Coating No. & Condition	LW-6		LW6-CR3	LW6-Z10
	As-coated	Heat-treated	As-coated	As-coated
Materials	W	W	W + Cr	W + ZrO_2
Density, % of theoretical	91	95	91	.....
Vickers Hardness (100 scale)	415	320	340	260
Rupture Modulus, psi x 1000	44	57	32	36
Elastic Modulus, psi x 10^6	24	37	15	13
Ratio: RM/EM	1.83	1.54	2.13	2.76

How the Plasma-Arc Torch Works

Normal high-current electric arcs, such as those used for welding, are relatively large and diffuse. The hot ionized gas within the arc—called plasma—is easily blown about by moving gas streams. It is not possible to use this arc effectively for heating rapidly moving gas. However, such an arc can be concentrated and stabilized by forcing it through a relatively small hole in a nozzle.

A typical arrangement for coating work has a tungsten electrode positioned near the entrance of a water-cooled copper nozzle. Electrically, the electrode is made negative (the cathode) and the nozzle is made positive (the anode). A flow of gas, such as argon, is directed through the nozzle. When the arc is struck, a large portion of it is forced into the nozzle by both electrical and aerodynamic effects. A substantial portion of the gas flow is forced through the arc. A cool gas layer next to the nozzle wall effectively insulates the nozzle wall from the tremendous heating effect of the arc column.

The jet of plasma issuing from the nozzle is essentially a high-velocity stream of hot, ionized gas—its temperature and velocity determined by the arc power, nozzle size, gas-flow rate, and nature of the gas used. This hot stream can melt, and accelerate to high velocity, particles of any known solid material which will melt without decomposition. When these molten particles strike a workpiece, they are impacted to form a dense, high-purity coating.

Stages in production . . .
of parts by the plasma-arc method. From top: polished brass mandrels for experimental rocket nozzles are dovetailed together on a common spindle; the form has been coated with a 0.050-in. layer of tungsten in 18 minutes under the torch; after disk-grinding to separate the four mandrels, the nozzles are completed by leaching away the brass with nitric acid.

Parts and coatings . . .
like these tungsten shapes are now possible from hard-to-work refractory materials—tungsten rocket-nozzle liners, tubes, crucibles, vacuum-tube grid cages, and coatings for graphite parts.

SURFACE FINISH FOR TUNGSTEN COATINGS
(microinches, rms)

As-coated	125
As-coated and heat-treated	125
As-coated and polished	30
Brass mandrel	20
As-coated (side facing mandrel)	35

revolution for machine-produced coatings if optimum thickness uniformity is desired. For assymetrical shapes, a hand torch is used with a fair degree of control. Because the coating is formed by particles striking the surface at terrific speeds, only easily accessible areas can be plated. This rules out narrow holes, blind cavities and deep V-shaped grooves. Plating tends to thin out over sharp external corners, so these should be broken slightly for best adherence.

• **Contour** should be controlled so the plasma jet stream deviates no further than about 45° from a line perpendicular to the point where metal is being deposited; otherwise plating efficiency drops off appreciably. For surfaces of revolution, this means no contour should exceed 45° from axis of revolution. There are two exceptions: When the torch angle is tracer-controlled or hand-held, angles up to 90° from the axis can be coated; when its diameter is about 1 in. or less, the whole part lies approximately within the plasma stream and torch angle becomes unimportant—though re-entrant corners cannot be plated.

• **Internal diameters** $\frac{3}{8}$ in, or larger can be coated to a depth not exceeding the diameter, following the same angle rule. Cylindrical shapes can be completely coated inside by reversing the part if the length does not exceed twice the diameter. Holes of 6 in. dia and larger, up to 36 in. long, can be plated clear through by extending the arbor-mounted torch inside. There is one solution, pending further development, for the problem of small holes—particularly those that vary in diameter: a "hole" can be created by making a liner on a mandrel and reinforced by a cast-in-place backup prior to installation.

• **Size of parts** is limited only by the dimensions of present production equipment: spindle has clearance for 18-in. radius, and the traversing headstock can pass parts 76 in. long beneath the torch. Largest part constructed to date is a 6-in.-long tungsten venturi with 4-in. bell diameters.

• **Diametral shrinkage** of about 0.7% occurs when a part made by expendable-mandrel technique is heat-treated for added strength. Surface finish does not change on treating; however, best finish is obtained on the side facing the mandrel.

• **Porous substrates** may require a ground coat to help the refractory metal-deposit cling to the discontinuous surface. With graphite, for example, a ductile undercoating will improve the bond for the tungsten coating when it is hit by high-temperature, high-velocity flames. The undercoating helps absorb the high shear stresses built up by differing thermal expansion rates of coating and graphite. These stresses can be remarkably high—sufficient to rupture the coating itself, distort the composite, or cause failure in the bond interface.

• **Finishing** plasma-arc plated refractories is difficult with single-point techniques, so abrasive grinding is preferred. Consequently, a part should be designed, wherever possible, so that the combination of plating and etching, plus a possible cut-off operation on the plunge-grinder, will handle the job.

• **Undersizing parts** by the thickness of the coating is an important point often overlooked. Areas not requiring a coating can be masked, though extensive masking increases coating cost. Heat-treated parts can be plated too, because the surface temperature is kept low with carbon dioxide gas streams.

• **Cost** of depositing high-melting-point coatings with the plasma-arc torch is, currently, comparable with that of depositing by Flame-plating, a detonation process employing an oxyacetylene reaction. Power costs are much higher, but the process is much faster—and there are no carbonization products to affect purity. Further, material cost is lower—so the process is inherently the cheaper of the two.

WHAT'S COMING?

In addition to more complete mechanical and physical property data on existing coatings, here are several developments now underway that should make plasma-arc plating a broader work-tool for the designer:

• **Wire-fed torches** are no longer experimental, but are in the prototype production equipment stage. This will mean lower costs through faster deposition rates, and a broader range of coatings—since any material in wire form can be laid down. Stainless steel coatings on cheaper substrates like aluminum have been successfully deposited, with bonds that will take 90° bends without peeling.

• **New alloy and ceramic coatings** show promise for high-temperature environments where erosion and chemical corrosion are big factors—combustion of the newer high-energy solid fuels, for example.

• **Pure, dense coatings** of the lower melting point metals—copper, aluminum, silicon, for example—are getting attention for electronic uses. Boron coatings for electron suppression, and strontium or barium surfaces for electron emission are being studied.

EDITOR'S NOTE:

For more about the way science is probing into plasma phenomena and possible applications, see these developments: Dec 1 '58, p 17; Aug 25 '58, p 5; June 16 '58, p 10; Feb 24 '58, p 14; Oct 7 '57, p 15.

Other recent articles on production processes for shaping hard-to-work refractory materials include:

"Slip-casting—Its Field Broadens," Oct 13 '58, p 84, compares slip-casting of metal-ceramics and powdered metals with other powder processes.

"Flame-plating for Wear Resistance," Sept '56, p 202, shows how to design parts for hard-surfacing with tungsten carbide by detonation process.

"Intermetallics at Work," June 9 '58, p 72, describes growing interest in a new kind of metal combination—neither alloy nor mixture—from which the well-known semiconducting materials originated.

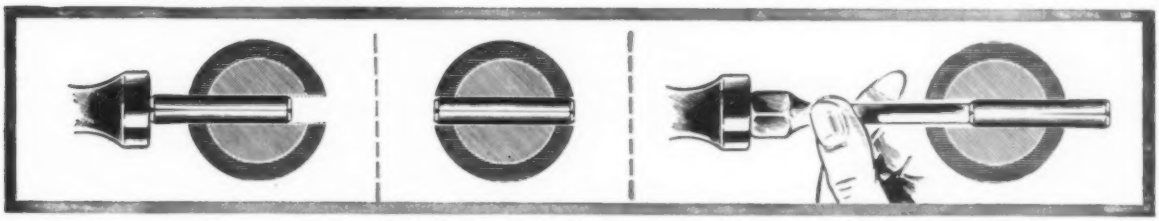
"Which Coating at High Temperature," Jan 20, '58, p 61, shows best coating design practice in a problem area.

what makes this fastener DIFFERENT?

Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey Dept. R40-122

Please send me the following free fastening information:

- ☐ Rollpin Bulletin
- ☐ Elastic Stop nut Bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

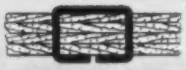
Street _____

City _____ Zone ____ State ____

BASICS OF STAPLING

(A)

Fiberboard and solid clincher

(B)

Paper and moving clincher

(C)

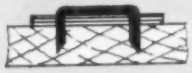
Corrugated cardboard and solid clincher

(D)

Soft material and "pass-by" solid clincher

(E)

One leg longer and turned out for use as hook

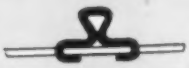
(F)

Fastening two or more materials together without clinching

(G)

Ring-type stitch to bind rope end

(H)

Through metal and movable clincher

(I)

Shaped to form soldering terminal for electronic applications

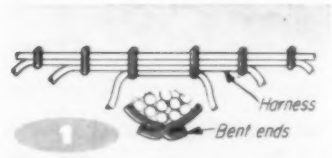
Maximum Dimensions

Crown length of a staple is generally 1½ in.; leg width, ½ in.; penetration in low-carbon steel, 1/16 in., in aluminum, ½ in. Penetration is the same regardless of whether the material is solid or laminated.

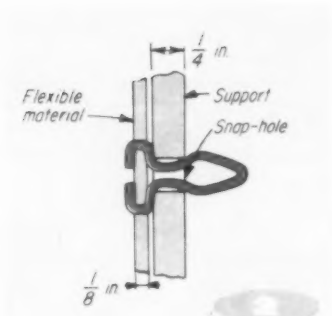
MORE WORK for

With the different types of staples and clinching methods now available, design is putting the versatile fasteners into almost everything—even electronic circuits. Basic types are shown at left. The clincher may be a fixed-anvil type that leaves a slight curve in the legs after forming (A); or a moving clincher that flattens them (B). When staple legs are shorter than material thickness they may be held like 2-legged tacks (F) in hard-enough material. Rods, cords, wires or similarly shaped items require a wrap-around staple (H). Some staples can be formed from continuous wire on a stitcher—this machine forms its own staples, then drives them.

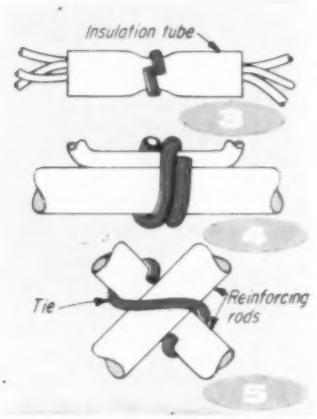
AND HERE ARE UP-TO-DATE USES . . .



Harness binding . . . by metal staples cuts costs—hand tying would be much slower. Staple ends are turned back so they will not cut into insulation.



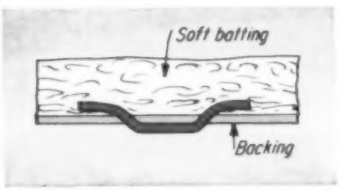
Snap-fastening staple . . . with special-shaped crown is designed to clinch onto yielding material such as rubber or fabric, and then be snapped through hole in panel or other support. Max material thicknesses a staple can at present accomodate are, approximately, 1/8-in. soft material, 1/4-in. support. Snap-hole dia varies with design requirements; therefore the staple maker's recommendations should be followed.



Wrap-around fastening . . . (3) is done either by a stapler or stitcher for light duty such as holding insulation in place. Heavy-duty application (4) requires stapler. Though this fastening has more wrap-around, it, too, is clinched in one operation. Wire up to 1/4 in. may be used for staple material. Staple tie (5) for reinforcing rods is in development; will be a timesaver substitute for present methods, which require several operations.

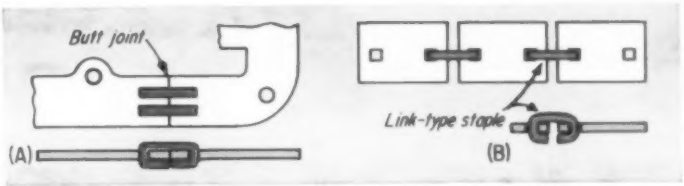
the BUSY STAPLE

HOWARD G ALLEN
Director of Research and Development, Bostitch Inc, East Greenwich, RI.



6

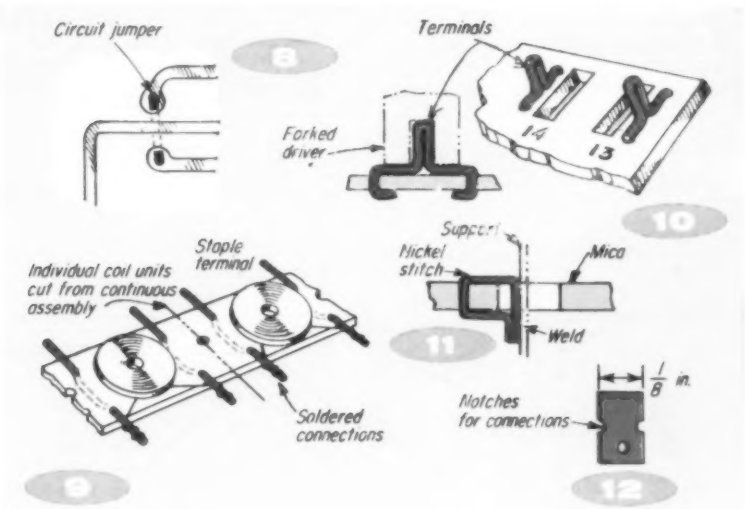
Outward clinch . . .
holds backing onto low-density material such as batting. Hand tool fastens this staple quickly and conveniently for low-cost fastening.



7

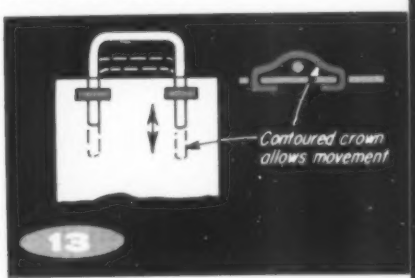
Staple-link . . .
is quickly applied to two parts that cannot be overlapped, e.g. gaskets (A) and bracelet-type product (B).

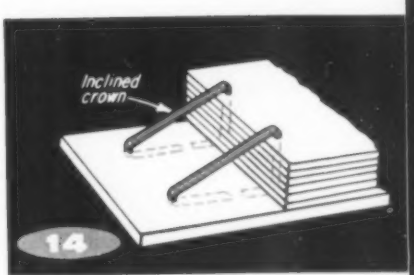
▼ **Five Applications in Electronics**



Electronic designs . . .
are finding increasing use for staples either as terminals, connectors, or mechanical fasteners. Circuit-jumper staple (8) in printed circuit is tinned copper. Outward-clinched staples serve as terminals (9) and speed assembly of coil unit. Terminal staples (10) require forked driver. Staple is supplied already formed. Staple serving as tube-element support (11) is pure nickel wire, stitched into place. Staples can be made wide enough (12) to allow notching, punching and forming to facilitate electrical connections.

Contoured crowns





Special crowns . . .
can be formed on staple, giving special functions. Examples: Contoured crown (13) leaves part free to move; inclined crown (14) fastens materials of two different thicknesses.

DEC.
1958

Dow

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

UNUSUAL CHARACTERISTICS OF STYRON END ELECTRICAL WANDERING

The most nearly perfect insulation material for electrical application known today is polystyrene. Electrical properties such as its high dielectric strength and its constant low dissipation factor make it ideal for the widely diverse applications discussed below.

Styron®, Dow polystyrene, plays an important role in the dosimeter, a device for measuring the amount of ionizing radiation. The dosimeter in the photograph is a simple electrostatic ionization chamber shaped like a fountain pen and worn in the pocket. The condenser is "loaded" with an electrical charge of known strength each morning before the unit is issued.

The presence of ionizing radiation, mainly gamma rays, causes the condenser to discharge. At the end of the day, the remaining charge is measured with an electrometer. The difference between the initial charge and the reading at the end of the day indicates the amount of radiation received by the person wearing the dosimeter. Styron plastic insulators isolate the condenser, effectively preventing loss of the initial charge.

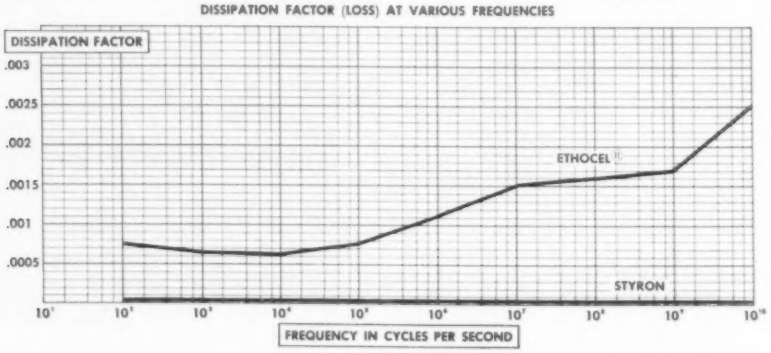
Electrical properties are one of many areas of investigation in which exhaustive Plastiatrics studies are being carried out by Dow. These studies survey every phase of plastics formulation, design, molding and finishing. Additional information on electrical properties as well as results of other Plastiatrics studies are available on request. Write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1525D.

DOW EXPANDED POLYSTYRENE. Styrofoam® provides lightweight, highly efficient insulation for this microwave antenna mounted in a high tower. The lens, which is used to relay TV and telephone signals across the country, consists of metal strips completely encased by the Styrofoam. (Therefore, not visible in this photograph.) The essential property of the polystyrene foam in this application is its low dielectric loss factor. It holds the strips apart electrically, almost as if only air were between them.

POLYSTYRENE ELECTRICAL PROPERTIES

Property	Method	
Dissipation Factor	ASTM D 150-54T	.0002 to 10^{10} cps.
Dielectric Constant	ASTM D 150-54T	2.54 to 10^{10} cps.
Resistivity	ASTM D 257-46	10^{20} to 10^{22} ohm.cm.
Dielectric Strength	ASTM D 149-44	5^{00} - 600 volts per mil at $\frac{1}{8}$" thickness
Arc Resistance	ASTM D 495-48T	80 - 100 seconds

DISSIPATION FACTOR (LOSS) AT VARIOUS FREQUENCIES



AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
STYRON ®666
STYRON 689 (Easy Flow)

MEDIUM IMPACT
STYRON 330 (Easy Flow—Translucent)
STYRON 777

HIGH IMPACT
STYRON 475
STYRON 440 (Heat Resistant)
STYRON 440M (Easy Flow)
STYRON 480 (Extra-High Impact)

HEAT RESISTANT
STYRON 683
STYRON 700

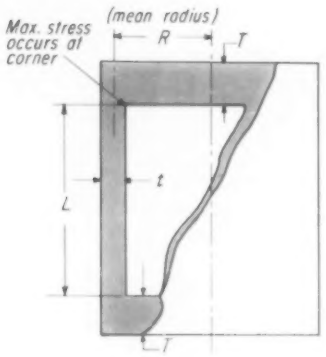
YOU CAN DEPEND ON DOW

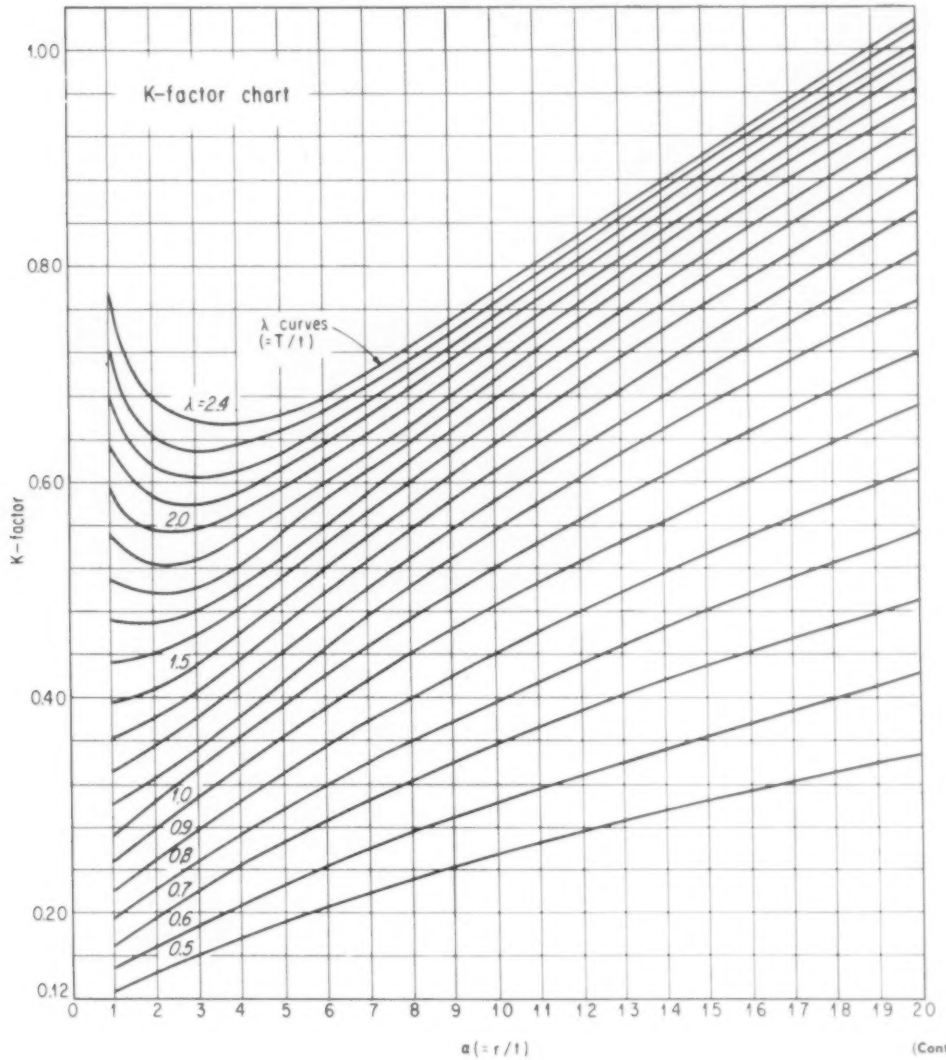
curves cut calculations for . . .

STRESS in Flat-ended Pressure Cylinders

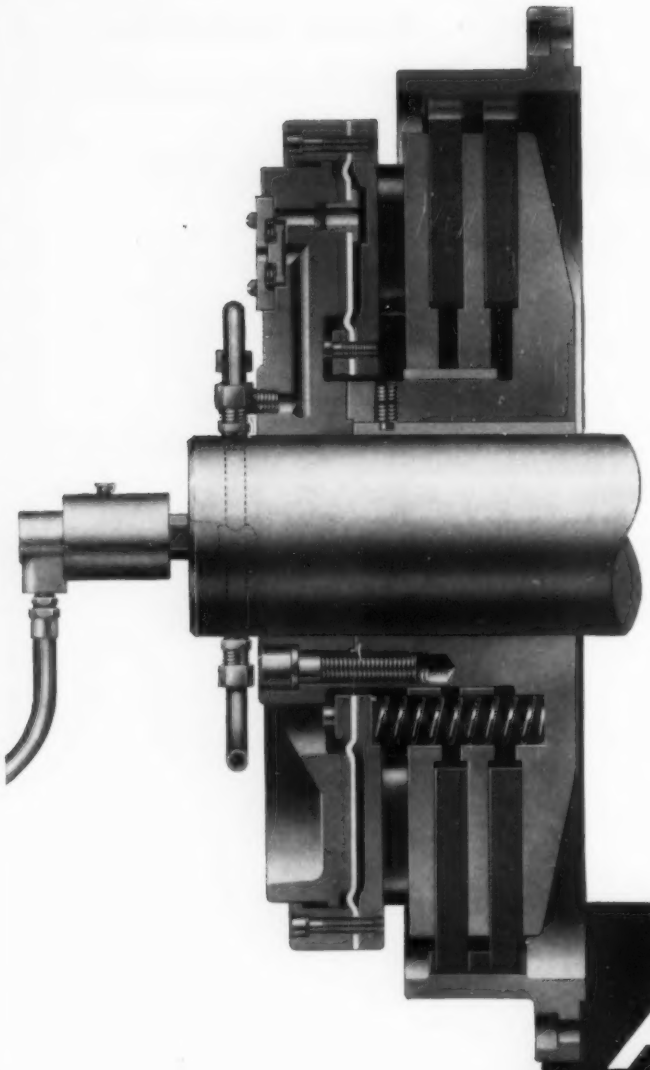
EUGENE J CATTABIANI
Atomic Equipment Dept, Westinghouse Electric Corp

The most common form of pressure vessels has flat ends. Although hemispherical, dished and ellipsoidal ends distribute stresses more evenly, they are used less often because the rounded-end vessels usually cost more. Stress calculations for flat-ended vessels are cumbersome, but K-factors below—plus formulas and other curves on continuing page—speed the answers.





(Continued on page 113)



1. Quickest acting, most responsive air clutch available!
2. Finger tip control!
3. Built-in quick release valves! (Optional)
4. Requires minimum volume of air!
5. No adjustment necessary!
6. Internally ventilated — cooler operation!
7. Operates at air pressures up to 140 psi!
8. Most compact!
9. Interchanges with and can be used to replace Dodge or other mechanical clutches in existing installations.
10. Available from stock in single and double plate types. Capacities from 8.5 to 460 hp at 100 rpm at 80 psi.

AIR-GRIP

NEWER! BETTER!

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER —your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone book for "Dodge Transmissioneer."

This air clutch, engineered to modern needs, provides maximum torque capacity in minimum space. Its operation requires less air, resulting in amazing sensitivity. It gives the operator split-second control—from "inching" to full engagement. Quick-release valves are built into the clutch itself, as optional equipment, for instant disengagement where such service is required.

The unique design of Air-Grip places the air seal disc at the end *farthest* from the pressure plates, which generate the heat inherent in clutch action. This combined with automatic internal ventilation, insures cooler operation and longer life under severest service. Call your local Dodge Distributor, or write for Bulletin.

DODGE MANUFACTURING CORPORATION, 1200 Union Street, Mishawaka, Indiana

STRESS in Flat-ended Pressure Cylinders (cont.)

THE FORMULAS:

Where $\alpha = R/T$; $\lambda = T/t$; $\gamma = L/t$; P = pressure, psi; $R \geqq 10t$; $\gamma/\sqrt{\alpha} \geqq 3$; Poisson's ratio is 0.3 ....

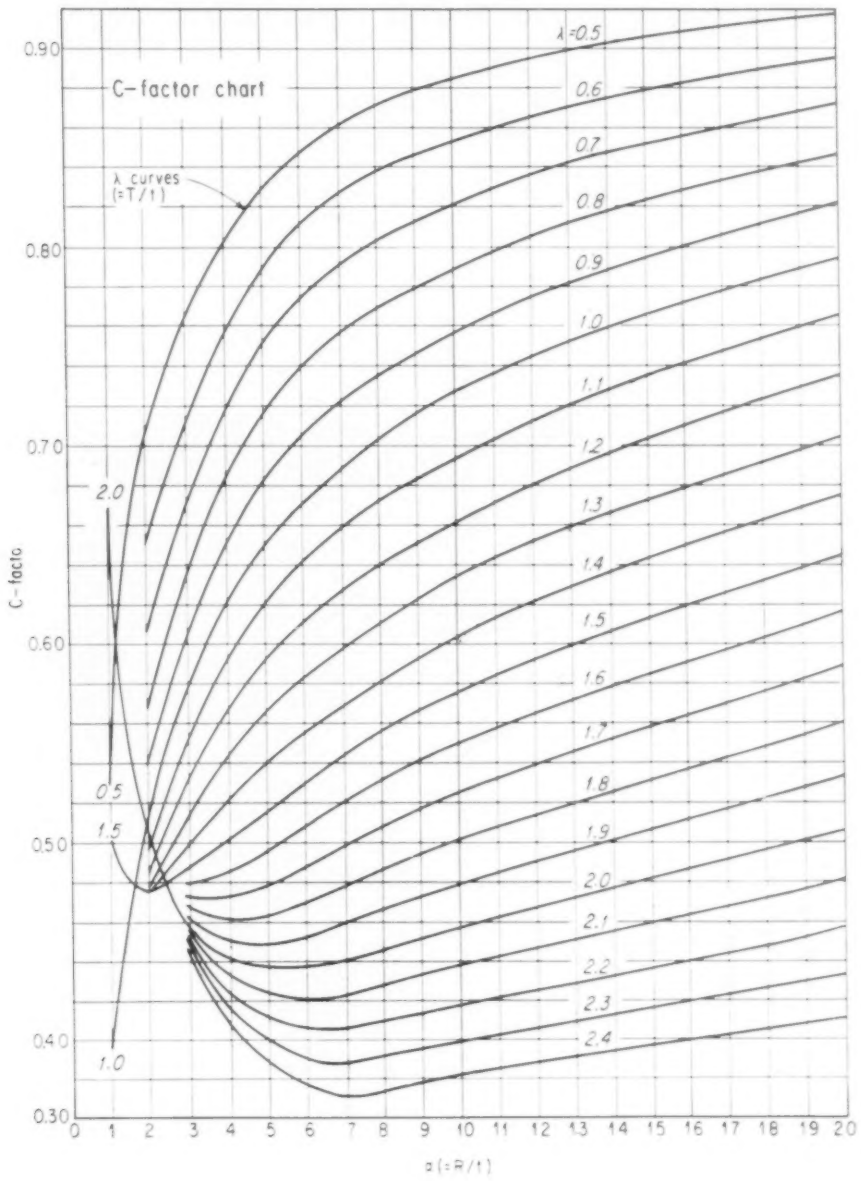
Stresses in cylinder are:

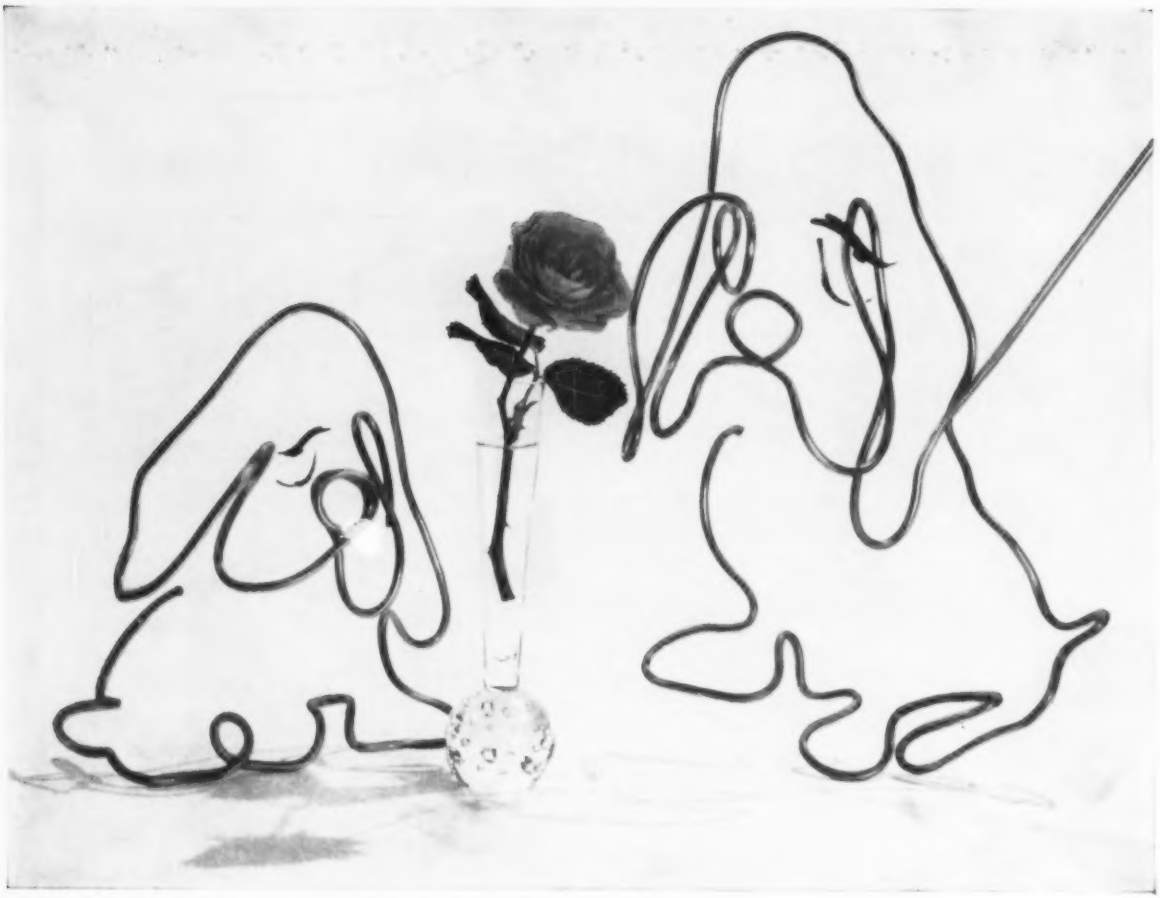
tensile	$= P(0.75\alpha^2 C + 0.5\alpha)$
shear	$= PK\alpha/\lambda$
hoop	$= \alpha P$

Stresses in plate are:

tensile,	$S = \frac{P\alpha}{\lambda^2}(0.75\alpha C + 3K)$
shear	$= 0.5P\alpha/\lambda$
bending at center	$= P\left(\frac{\pm 1.24\alpha^2 C}{\lambda^2} - \frac{S}{P}\right)$

Values K and C are found from the charts.





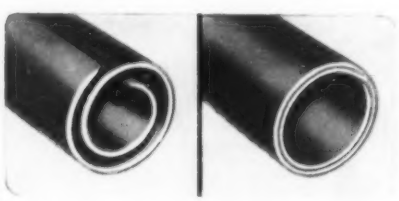
There's practically no limit to the things Bundy can mass-fabricate

. . . and we do it with Bundyweld, the stronger, safer steel tubing that's made for easy bending

SKILLED Bundy® technicians turn out many a strange shape—each to its exact tolerances. At Bundy, you get precision *in mass-fabrication*. Jigs, fixtures—even machines—are designed by Bundy specifically to cut customers' unit costs.

You get Bundyweld® Tubing, too. An exclusive process (right) gives it unique physical properties. So Bundyweld—master of volatile refrigerants and high-pressure brake fluids—has become the safety standard of two major industries.

Bundy engineers will design your tubing part, or work with you on its development. When we fabricate your parts, you can count on careful packaging, on-time delivery. Bring *your* tubing problem to Bundy. Contact us today!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

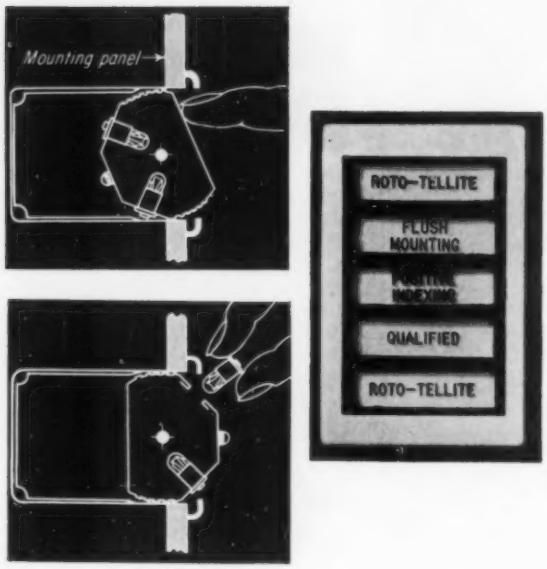
Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high burst strength. Sizes up to ¾" O.D.

There's no real substitute for Bundyweld Tubing

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY



Indicator light rotates . . .

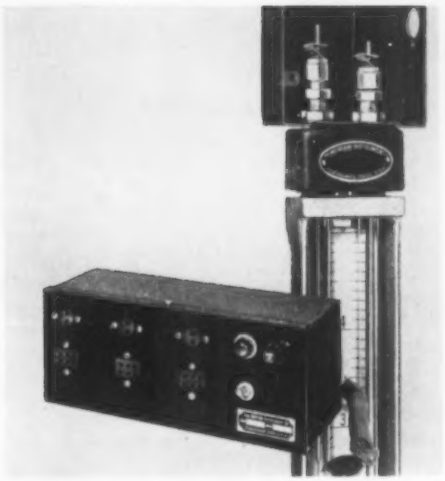
to permit changing legends and two bulbs of rotating lamp capsule. No close-tolerance panel cutout is required, and no screw heads show on panel front. Single units stack horizontally and/or vertically. Single assemblies are available with 1 to 20 lights. Supplied to accommodate 6, 12, or 28-v dc and 115-v ac systems, 60 or 400 cps. Lamp capsules are made of high-temperature molded nylon. Operates in ambient temperatures of −67 to 160 F. Special circuitry, when required, can be incorporated in modular control capsule as an integral part of each individual light. Units weigh about 1¼ oz each. Delivery is 2 to 4 wk. **Master Specialties Co, 956 E 108th St, Los Angeles 59.**

Circle 1, Reader Service Card

Air-filter gage . . .

indicates when filters are clogged and need replacement or cleaning. When filters are new, white ball is below mark on indicating plastic tube. When filters build up too much resistance to operate efficiently, ball rises above mark. One unit is used in pressure range of 0.04 to 0.15-in. water column, indicating pressure increases of 0.01 in water column at low end of range. The other unit, for pressures of 0.15 to 1.0-in. water column, indicates pressure increase of 0.02-in. water column at low end of range. Operation at a specified pressure is obtained by adjusting valve in top brass fitting. Gage indicates either pressure or vacuum and can also be supplied to indicate differential pressure. Prices range from $7.78 to $3.89 each. Small quantities from stock; larger quantities within 4 wk. **Henry G Dietz Co Inc, 12-16 Astoria Blvd, Long Island City 2, NY.**

Circle 2, Reader Service Card



Sensitive pressure switch . . .

consisting of a contactor manometer and a relay-power-supply package, may be used for alarm signalling and/or control in applications involving pressure, vacuum, differential pressure, flow and liquid level. Special indicating fluid gives make-or-break control sensitivity of 0.005 in. of water; sensing pressure increments as small as 0.003 oz per sq in. Switching functions are handled by relay-power unit, which operates at 110 v ac. Modular construction uses interchangeable plug-in circuit cards governing one contact point on manometer. May be removed or inserted without affecting operation of other points. Individual load relays are fully enclosed and have DPDT switching action. Available as plug-in or tamperproof models, for one to five contact points. Contact capacity is 5 amp per point at 115 v ac. Contactor manometer is about $50 with single-point pressure switch priced at $50; two-point, $75 and three-point, $100. Delivery within 2 wk. **Meriam Instrument Co, 11036 Madison Ave, Cleveland 2.**

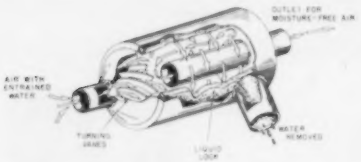
Circle 3, Reader Service Card

Blended Teflon components . . .

are fabricated from fluorocarbon resin base with inorganic additives to achieve improved physical characteristics. Said to exceed pure Teflon by a factor up to 10 in resistance to deformation under load; resistance to wear is increased by as much as 500 times; compressive strength and stiffness can be increased 4 to 5 times. Additives are said not to lower Teflon's desirable physical characteristics, such as lubricity and chemical inertness. Components include mechanical parts, bearings, seals, piston rings and gaskets. Made to specs from subminiature to 10 ft dia. Priced about 10% higher than comparable parts of pure Teflon. Delivery in 3 to 4 wk. **Modern Industrial Plastics, 3337 N Dixie Dr, Dayton 14.**

Circle 4, Reader Service Card

. . . CONTINUED ON PAGE 116



Self-emptying separator . . .

without moving parts, removes, under minimal pressure-drop limits, from 97 to 100% of free moisture from any gas stream. Said to be effective with alcohol, ammonia, Freon and, to some degree, on oils. Removes moisture from any gas compatible with materials from which separator is made. Separation is accomplished without assistance of gravity, so long as ambient pressure is less than pressure of airstream inside separator. Originally developed to meet requirements of air condition equipment in aircraft. Preliminary tests indicate moisture removal appears feasible at sub-freezing temperatures with heating coil imbedded in wick. To specs. Priced competitively. Normal delivery in 120 days. **South Wind Div, Stewart-Warner Corp, 1514 Drover St, Indianapolis.**

Circle 5, Reader Service Card

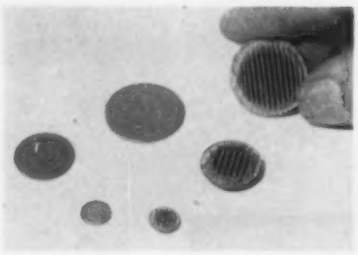
Roller keeps webs taut . . .

and smooth by a rotating action that imparts width-wise stretch. Bow-shaped roller is $\frac{7}{8}$ in. dia. x 3 in. long. Keeps ribbon, cloth tape and other narrow-width webs at full width and free from wrinkles and creases during processing. Roll lengths from 1 to 320 in. for all webs, textile, paper film and foil are available. **Mount Hope Machinery Co, Taunton, Mass.**

Circle 6, Reader Service Card

High-temperature filters . . .

for hydraulic and pneumatic line filtration are offered in 8 pore sizes ranging from 5 to 250 microns. Stainless steel sintered porous wire mesh disk-type filter elements have 8:1 increase in effective filtering area, providing high flow rates, low pressure drops and high dirt capacity. Both can be installed with gaskets, snap rings, staking methods, press fits, silver solder, welding or with epoxy resins. Can



be cleaned and restored to original filtering capacity. Wire-cloth disk elements are made in 25 standard diameters ranging from 0.0670 to 1.2344 in. and in three standard thicknesses. Wire mesh elements are offered in five standard diameters of 0.375 to 1.368 in. and three standard thicknesses. **Bendix Filter Div, Bendix Aviation Corp, 434 W 12 Mile Rd, Madison Heights, Mich.**

Circle 7, Reader Service Card

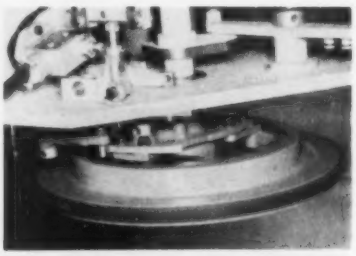
Accumulator absorbs shock . . .

reduces pressure peaks and smooths out pump pulsation. Also acts as booster in storing hydraulic energy. Available in 13 sizes from 15 to 7500 cu in. for units up to 2000 psi. Standard outer shell is steel, in two parts, secured with clamp rings. Barrier is hat-shaped with rim that forms effective O-ring to seal oil from gas chamber. Barrier rolls inside-out when charging or releasing, without friction or wearing. Female threads to customer specifications are provided for ease of installation. Dome-end casing is said to be stronger, require less metal and to be lighter and less expensive than previous models. **Special Products Co, Golden, Colo.**

Circle 8, Reader Service Card

Single-revolution clutch . . .

with adjustable torque control provides automatic, positive rotation on a shaft from a continuously rotating source of power. Ball-bearing-equipped flywheel is



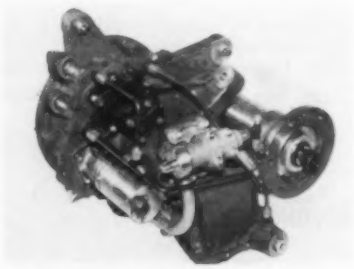
said to lend itself to V-belt, gear or direct drive, mounting either at end or in middle of shaft. Expanding brake-shoe type clutch features positive positioning device at disengagement and may be used for clockwise or counterclockwise rotation. Rated $\frac{1}{3}$ hp at 100 rpm, clutch is for speeds to 150 rpm. Standard shaft size is $\frac{3}{4}$ in. but $\frac{1}{4}$ to 1 in. units are available. **Theodore M Wright Inc, Dept L, PO Box 286, Camden 1, NJ.**

Circle 9, Reader Service Card

Solid-state batteries . . .

are said to be capable of delivering a combined voltage of 1600 v. In four sizes, batteries with 95-v potential come in 0.14 cu in.; with 190-v potential in 1.15 cu in.; with 380-v potential in 1.57 cu in. and with a 950-v potential in 2.87 cu in. **Patterson, Moos Div. of Universal Winding Co, 90-28 Van Wyck Expressway, Jamaica, NY.**

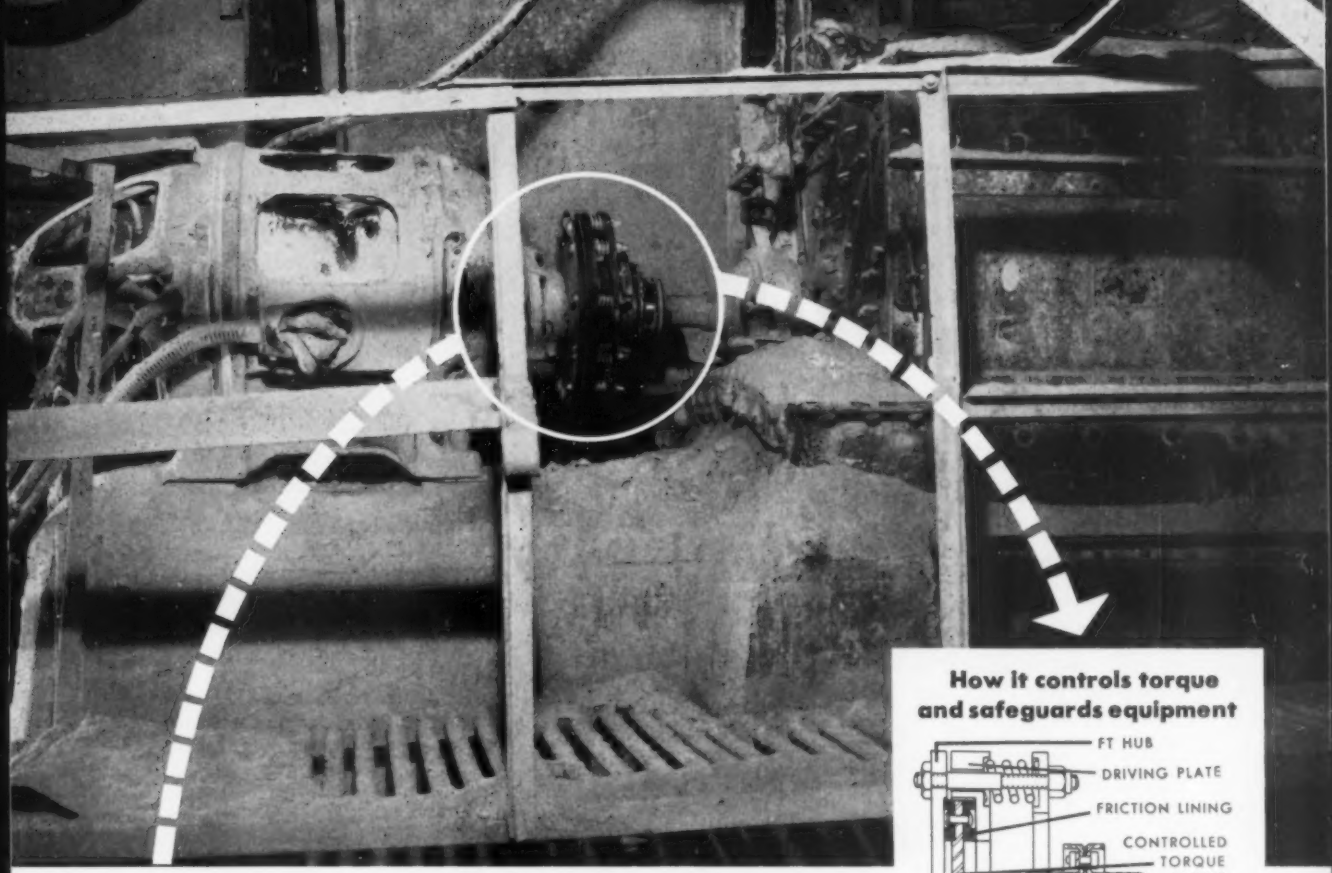
Circle 10, Reader Service Card



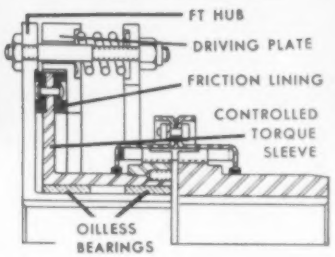
Constant speed control . . .

combines standard hydraulic pumps and motors with planetary gearing. Various power ranges and speed ranges are provided by changing the hydraulic units. Present size range is from 20 to 90 kva, with units for 60 kva available now. Input speed varies from 3800 to 7000 rpm max with output speed constant at 6000 rpm for 20, 40 and 60-kva models; efficiencies vary from 78 to 97%. Normal steady-state speed-control accuracy is said to be 0.25% over an oil-temperature range of 200 F. Drive operates in any attitude. It is direct-engine-driven, can be engine-

. . . CONTINUED ON PAGE 118



How it controls torque and safeguards equipment



Protect machines from overload damage with FALK Controlled Torque Couplings

The above picture shows a Falk Controlled Torque Coupling connecting a 150 hp motor to a hammermill. Formerly, when tramp iron got into the mill, it was necessary to rewind the motor at least twice a year. But, in the 2½ years after installing a Falk Controlled Torque Coupling, no motor repairs were required. *That is real saving!*

Wherever overload danger exists, a Falk Controlled Torque Coupling gives positive protection against machinery damage from excessive torque or jams. This unique coupling has an adjustable friction slip clutch which can be set at *any* predetermined torque limit. Thus, transmission of dangerous shocks is prevented...overloads are limited...shaft breakage is eliminated.

Another big advantage is that, when the cause of the overload is removed, the entire coupling will rotate and transmit power without resetting, and *without replacing parts or repairing the coupling*....And, the Controlled Torque Coupling incorporates the famous Falk Steelflex torsional resilience to smother ordinary shock and vibration, plus the ability to accommodate shaft misalignment....Consult your Falk Representative or Authorized Falk Distributor. **Ask for Bulletin 4100.**

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities.

Here (as in photo), the torque-control hub is shown mounted on driving shaft. From this hub, power is transmitted through friction lining to controlled torque sleeve. Load to be transmitted is determined by the (pre-set) pressure on friction lining. In case of overload, this hub still rotates until power is shut off—but the rest of the coupling and the driven machine will slow down or stop.

Motor Shut-off Control

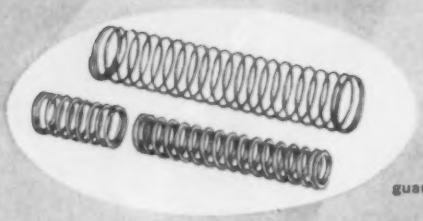
By adding an automatic cut-out switch with V-belt connection to driven shaft, motor can be stopped immediately. With the standard hub mounted on driven shaft, the switch opens the electric circuit when speed of switch falls below predetermined value.

FALK

...a good name in industry

Spotlighting Reliability!

MICRO-PROCESSED I-S BERYLLIUM-COPPER SPRINGS

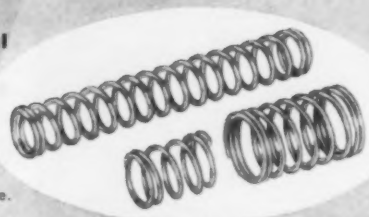


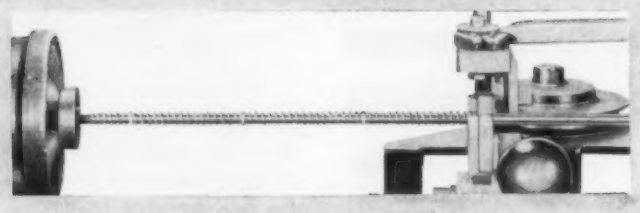
Exclusive Design Advantages

I-S micro-processed beryllium copper springs, designed into control devices, relays, circuit breakers, etc., result in improved performance and lower cost. Their high degree of uniformity eliminates the necessity of hand adjustment during assembly and is your guarantee of uniform performance.

Important Electrical Advantages

I-S micro-processed beryllium copper springs receive laboratory-proven heat treatment, therefore they can operate at higher temperatures and carry more current with less temperature rise.





THE *Ideal* SPRING MATERIAL

Beryllium copper is an ideal spring material because of its natural inherent characteristics. It is non-magnetic, has the corrosion resistance of pure copper, high electrical conductivity, high wear resistance and a high endurance life. The temperature used to develop spring temper also serves to relieve internal stresses remaining from cold work. The ability to conform to jigs and holding fixtures during heat-treatment makes it particularly well suited for our specially designed, patented machines. The wire is placed upon the mandrel in an exacting manner, strictly in accordance with the engineered design. The springs are set to this design by heat-treatment while they are still on the mandrel. There is no spring back upon removal from the mandrel with the result that the springs are uniform, stable and free from drift.

CALL OR WRITE FOR THE I-S CATALOG covering in detail compression springs, flat springs, strip springs, contact rings, contact strips and screw machine products.

IN SWEET'S PRODUCT DESIGN FILE

INSTRUMENT SPECIALTIES CO • INC

234 BERGEN BLVD. "MICRO-...PROCESSED" I-S BERYLLIUM COPPER SPRINGS LITTLE FALLS, N. J.

Telephone: CLifford 6-3500

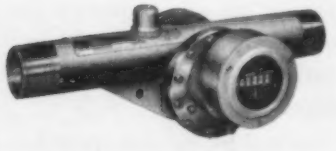
pad-mounted or universal-shaft-driven. Planetary gear train is principal power vehicle and hydraulic components differentially add or subtract speed and power as required to maintain constant output speed. Variable-displacement pump-motor provides control by varying displacement and direction of oil flow in response to hydraulic signal from speed governor. **Vickers Inc, Detroit 32.**

Circle 11, Reader Service Card

Dc motor with heat exchanger motor . . .

for variable- and constant-speed applications is offered in ratings from 25 to 300 hp. Constructed in explosion-proof enclosure or standard enclosed construction. Designed for indoor or unprotected outdoor service and for machine tool and materials handling applications. Adjustable speed range extends from 5% of base motor speed by armature control (constant torque) to 400% of base speed by field control (constant hp). Integrally mounted, ac fan motor supplies constant flow of cooling air regardless of speed of motor. Heat-exchanger tubes of heavy-section, high-tensile-strength aluminum alloy are distributed around periphery of field ring for air-to-air heat removal. Motor mounts horizontal or vertical with shaft up or down. **Louis Allis Co, Dept. P, 427 E Stewart St, Milwaukee 1.**

Circle 12, Reader Service Card



Industrial-liquid flowmeter . . .

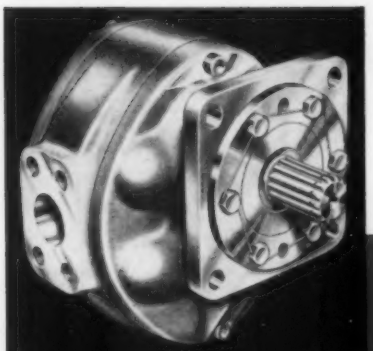
totalizes 20 to 220 gpm at 1500-psi working pressure. Standard flow range is 10:1. Meter is nonelectrical. Magnetic output coupling drives a 7-digit number wheel register, eliminating running seal or stuffing box. Constructed of stainless steel for corrosive and hard-to-handle liquid applications. Handles nonlubricating

(Continued on page 120)

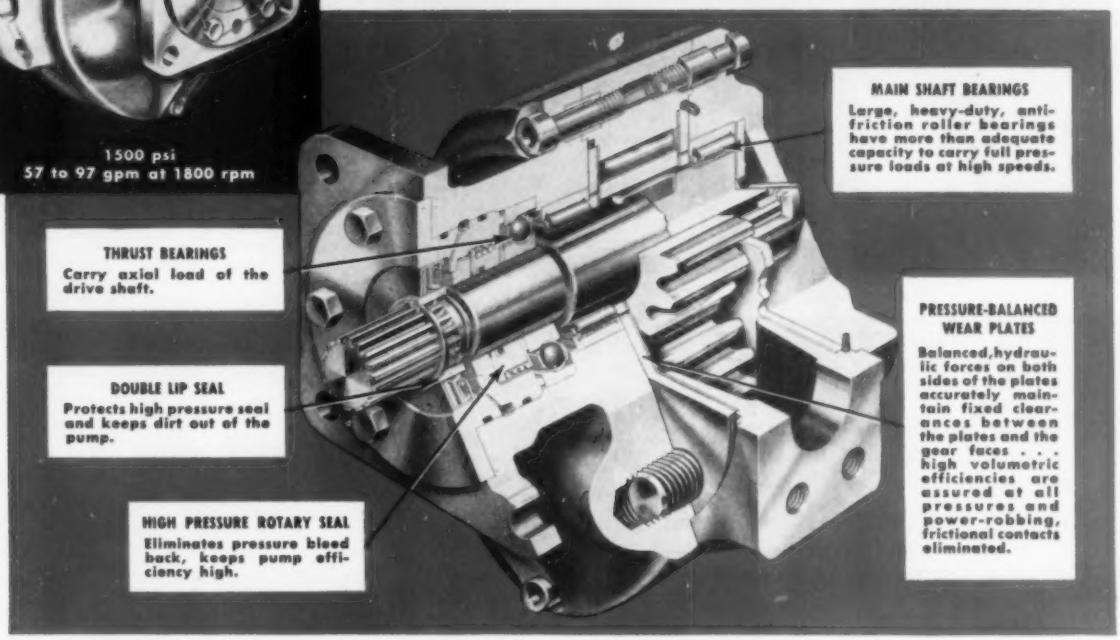
NOW • Added Service Life for the Accepted Leader Among Heavy Duty Fluid Power Pumps

HYDRECO

Series 3000K
FLUID POWER PUMPS



1500 psi
57 to 97 gpm at 1800 rpm


MAIN SHAFT BEARINGS
Large, heavy-duty, anti-friction roller bearings have more than adequate capacity to carry full pressure loads at high speeds.
THRUST BEARINGS
Carry axial load of the drive shaft.
PRESSURE-BALANCED WEAR PLATES
Balanced, hydraulic forces on both sides of the plates accurately maintain fixed clearances between the plates and the gear faces . . . high volumetric efficiencies are assured at all pressures and power-robbing, frictional contacts eliminated.
DOUBLE LIP SEAL
Protects high pressure seal and keeps dirt out of the pump.
HIGH PRESSURE ROTARY SEAL
Eliminates pressure bleed back, keeps pump efficiency high.

APPLICATIONS

EARTH MOVING EQUIPMENT
CONSTRUCTION MACHINERY
MATERIALS HANDLING EQUIPMENT
AGRICULTURAL MACHINERY
MOBILE and GENERAL
INDUSTRIAL EQUIPMENT

Member NFPA

The basic design of HYDRECO Fluid Power Pumps has been proven in thousands of successful installations . . . on Earth Moving, Materials Handling and Agricultural equipment . . . where dependability, efficiency and ruggedness are of prime consideration. *Now*, this famous design has been refined by improvements that give you this outstanding performance PLUS – *substantially extended service life – three times greater!* Translated in terms of dollars and cents, this greater service life adds value to the Pumps you buy and pays your customers extra dividends on their investment.

Check the features shown above . . . combined, they enable HYDRECO Series 3000K Pumps to set new standards in performance, efficiency and trouble-free service.

Write–

for performance and installation data on HYDRECO 3000K Series Fluid Power Pumps.

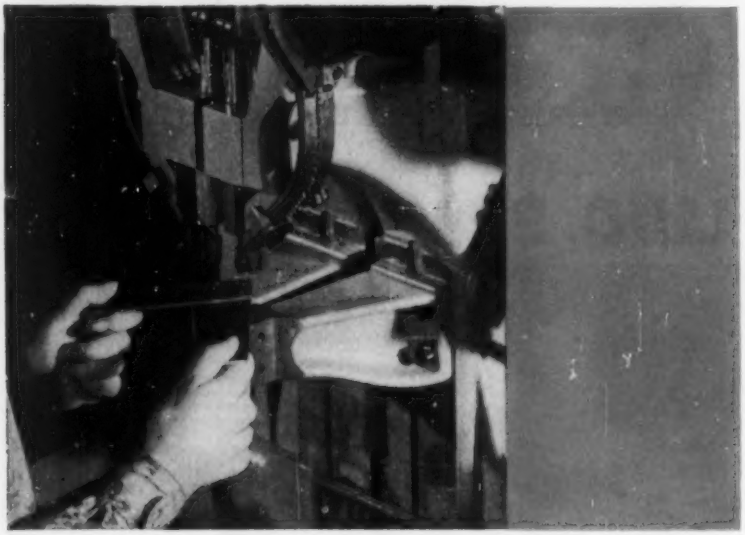
HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
KALAMAZOO • MICHIGAN

Hydreco Division
THE NEW YORK AIR BRAKE COMPANY
9012-12 East Michigan
Kalamazoo, Mich.

Please send me complete information on HYDRECO Series 3000K Pumps.

Name_____
Company_____
Address_____
City_____ Zone____ State_____

CUT UNIT ASSEMBLY COSTS . . .
GET HIGH-SPEED, LOW-COST FASTENING . . .
TAKE ADVANTAGE OF AUTOMATIC ASSEMBLY



Milford shows you how to cut assembly costs!

Tubular rivets are basically a low-cost fastener. Feed and clinch them with automatic Milford Riveters, and you *multiply* the cost savings inherent in rivets.

The Milford Riveter shown here is only one of a full line of automatic machines. Bench or floor models . . . single or multiple spindle . . . manual or automatic, the Milford Riveter line is designed to solve your toughest assembly problems.

Remember . . . these are *basic* rivet-setting machines. They can be tooled quickly and inexpensively for your particular assembly needs. And it's up to you whether you buy or lease. For a complete line of fasteners . . . for fast, trouble-free assembly—look to Milford first!

MODEL 220-BH

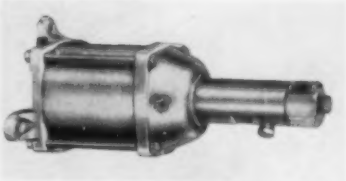
RIVET CAPACITY: 3/32" dia. by 1/8" length to 9/64" dia. by 1/4" length.
THROAT DEPTH: 11"
POST HEIGHT: From 0" to 18"
HOPPER: Rotary
CLUTCH: Single trip, non-repeating Horton type
FLYWHEEL: 260 R.P.M.
DRIVE: V-belt noiseless

MODEL 220-BH

THE MILFORD RIVET & MACHINE CO.
MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

fluids such as LP gas, dry fuel gases and water. Accuracy is said to be ½% with no periodic recalibrations. **Rotron Controls Corp, Woodstock, NY.**

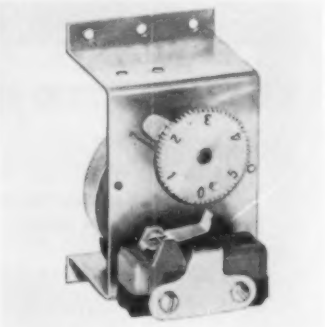
Circle 13, Reader Service Card



Air-hydraulic boosters . . .

mount vertically to prevent dead weight of internal parts from causing distortion in seal. Porous bronze air filter is threaded into breather hole of air chamber. Chambers, of honed seamless steel tubing, are connected by hardened steel tie-rods. Said to be priced lower than comparable units. **Wilton Tool Mfg. Co Inc, 9525 Irving Park Rd, Schiller Park, Ill.**

Circle 14, Reader Service Card



Adjustable time-delay relay . . .

is driven by a synchronous motor from any standard voltage source. Unit is adjusted by turning indicator lever to desired position on notched 1¾-in. dial, which has 60 notched positions and is numbered at every tenth point. Supplied on bracket for mounting. Adjustable timing ranges include 0 to 15 sec, 0 to 30 sec, 0 to 60 sec and 0 to 120 sec. Contacts are rated 20 amp, 480 v, noninductive. **Zenith Electric Co, Dept PEN, 152 W Walton St, Chicago 10.**

Circle 15, Reader Service Card

Journal lubricator . . .

was developed for railroad cars. Wood felt base serves as an oil reservoir, prevents damage to lubricating pad and eliminates danger of "wick grabs" by bearing. Twin foam-neoprene design achieves positive journal contact without excess pressures

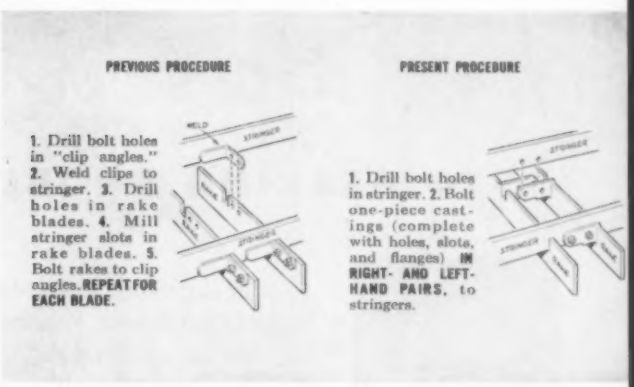
(Continued on page 122)

How to cut costs, improve product design with stainless steel close-tolerance castings

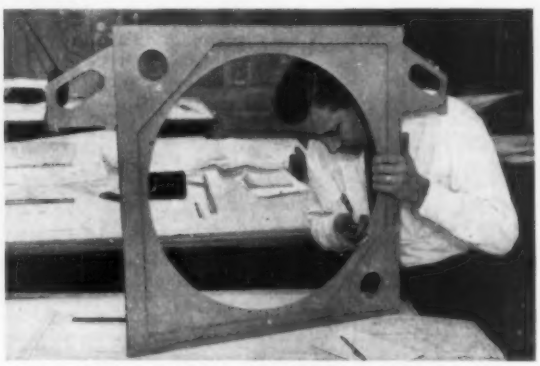
Cooper Alloy design collaboration with advanced casting techniques can simplify your fabrication, cut your costs. Here's how:

Casting of intricate parts: Jet engine afterburner component, cast for Pratt & Whitney Aircraft by Cooper Alloy, is a tangle of projections and cavities. Required, however, were the most precise dimensions to make for automatic precision machining. Shellcast® shell coring and CO_2 process cut down rejection and machining costs.

Strength and quality: Castings stronger than forgings! These Cooper Alloy nuclear service fittings possess high-temperature yield strengths 20% higher than minimum code specifications. Tough quality requirements have been met and bettered on a regular repetitive quality basis.


PREVIOUS PROCEDURE
1. Drill bolt holes in "clip angles." 2. Weld clips to stringer. 3. Drill holes in rake blades. 4. Mill stringer slots in rake blades. 5. Bolt rakes to clip angles. REPEAT FOR EACH BLADE.
PRESENT PROCEDURE
1. Drill bolt holes in stringer. 2. Bolt one-piece castings (complete with holes, slots, and flanges) IN RIGHT- AND LEFT-HAND PAIRS, to stringers.

Part redesigned, simplified, assembly costs lowered. Classifier rake blade, Shellcast® by Cooper Alloy for Dorr-Oliver Inc., was originally made by welding cast and machined elements. Close-tolerance, smooth-surface shell castings made possible design change to one-piece cast unit, eliminating welding and much of the assembly costs.



Casting of thin-walled close-dimensioned parts. Tennessee Eastman filter frame plate previously required a good deal of careful milling on thin inner web. Combined use of shell core in a sand mold held tolerances, eliminated milling operation.

Product improvement: Gear lugs on adjusting ring for Manning, Maxwell & Moore pressure safety relief valve, formerly sand cast, are now being produced directly by Shellcast® process. Dimensional accuracy possible with shell castings permitted redesign of part to give more lugs, finer adjustability in use.

If you haven't looked over your fabrication and assembly costs lately, check the unusual cost-saving techniques listed in the capsule stories shown above. They are typical of Cooper Alloy advanced casting know-how. Many parts and assemblies that you probably haven't even considered as makable by castings, can be now by Cooper Alloy, specialists for over 35 years in casting *only* stainless steel.

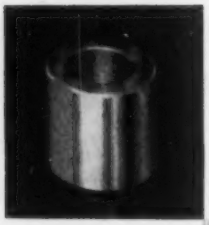
Want more information? To learn more of how Cooper Alloy know-how can help cut *your* manufacturing costs, write for our free 16-page booklet, "Cooper Alloy—Pioneering in Stainless Steel." Also available, information on the other problem-solving Cooper Alloy products listed below.

COOPER ALLOY

Corporation • Hillside, New Jersey

SPECIALISTS *in Stainless Steel valves, fittings, castings; Plastic pumps, pipe, valves, fittings*

CIRCLE 165 READER SERVICE CARD



THE

simplest answer

TO BEARING PROBLEMS

Bunting capability and leadership in the field of Cast Bronze Bearings and parts are well established and widely recognized. Today Bunting offers an equally comprehensive and responsible service in the field of Sintered Powdered Metal Bearings and parts.

Bunting's special knowledge and facilities make Sintered Powdered Metal products available in many applications not heretofore considered feasible. We can help you find the simplest answer to your individual problem, be it Cast Bronze or Sintered Metal.

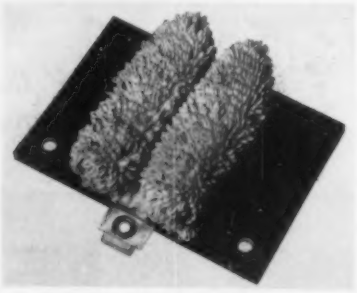
A wide range of stock sizes of Bunting Cast Bronze and Sintered Powdered Bronze self-lubricating, plain and flange bearings, thrust bearings and bars are available from Bunting distributors everywhere in America.

Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

Bunting®

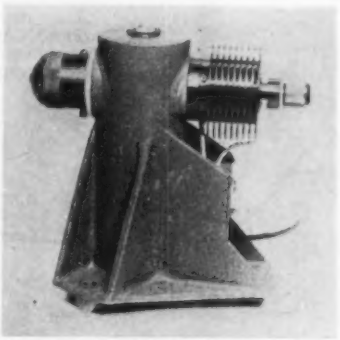
BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities



that cause elevated operating temperatures. Also, best wicking action is said to be obtained in center section between neoprene cores. Two strands of tufts (72 wicks) clear journal on each side. As car starts to move, oil-saturated tufts from one side are drawn under journal, depositing oil. **Premier Mfg Corp, 107 Penn Ave, Pittsburgh 21.**

Circle 16, Reader Service Card



Tilt-angle transducer . . .

is optical-electronic device that automatically detects and records angular change to within ½ sec of arc. Measures positional disturbances of structures and corrects level by feeding of disturbance signal directly into servomechanism. Signal can be applied to chart recorder to illustrate and measure angular change. Transducer is capable of monitoring motion of system elevation or azimuth axes and recording, with time index, information needed to correct basic data. **Keuffel & Esser Co, Adams & 3rd Sts, Hoboken, NJ.**

Circle 17, Reader Service Card

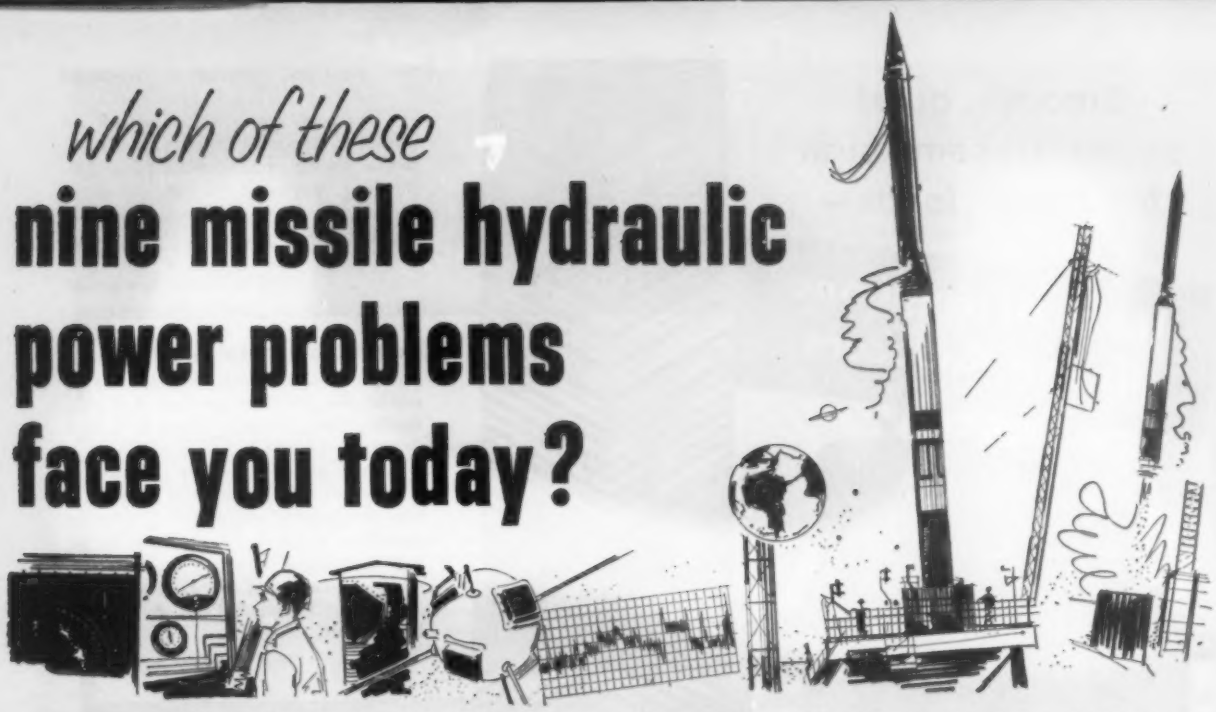
Thermosetting plastic . . .

in rod and sheet in a variety of sizes and shapes is said to exhibit electrical properties associated with Teflon. Dielectric constant, 10^2 to 10^{10} cps, is 2.2; dissipation factor, 10^2 to 10^{10} cps, is below 0.0003; flexural strength is 12,000 psi; izod impact strength is 0.3 ft-lb per in. of notch; water absorption, 0.002% gain in 24 hrs at 77 F. Material withstands continuous

(Continued on page 124)

which of these

nine missile hydraulic power problems face you today?



PROBLEM

weight and space Eastern hydraulic power units are made of *miniature* high-speed gear pumps, close-coupled directly to performance-tested electric motors. Even when components are added such as reservoir, expansion-relief valve, expansion bellows, adjustable pressure-regulating valve, check valves – total weight is under 5 pounds, size only 7¾" x 2¾" x 7½" (Eastern unit illustrated used as example).

PROBLEM

high temperatures Most Eastern units normally operate at temperature range of –67°F. to +220°F. Higher temperature limits are no problem.

PROBLEM

reliability The necessity for high performance and reliability in executing commands of the guidance system, makes hydraulic systems a vital link in performance. Eastern systems have gained the reputation for outstanding reliability under extreme environmental conditions when operating at high speeds.

PROBLEM

high-speed power take-off Eastern gear pumps with speeds of 24,000 RPM permit direct drive by main power source.

PROBLEM

complicated, heavy plumbing Running lines from power unit to remote areas can be eliminated by using individual self-contained hydraulic power units at each point. You gain maximum flexibility, simplicity, reliability, while removing more weight in plumbing than you add in power packs.

PROBLEM

compromised accessory performance When all accessories adapt the 3000 PSI main system pressure by means of power-wasting, heat-producing, pressure-reducing valves, performance suffers. Eastern units offer individually selected hydraulic fluids and pressures to give optimum performance to each accessory in the system. Eastern units have capacity to 1.5 GPM at pressures to 3000 PSI.

Eastern Aviation Bulletin 350 provides a wealth of performance data. Request your personal copy today.

PROBLEM

fluid contamination System cleanliness is insured by a sealed system and continuous filtering of pump discharge.

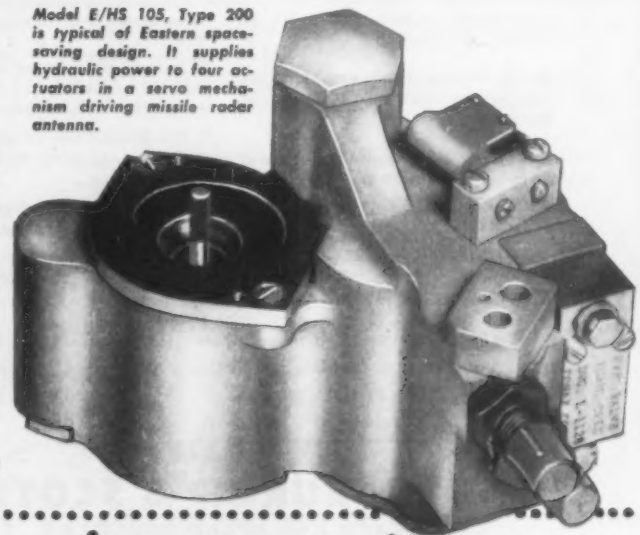
PROBLEM

runaway costs Eastern uses standard mass-produced components, arranges them to match your space, to give you a custom design with minimum development expense.

PROBLEM

divided responsibility Eastern welcomes the opportunity to develop components or complete missile subsystems in hydraulic power, electronic cooling and refrigeration, and pressurization. Design and manufacturing responsibility from one experienced source is your assurance of dependable performance. Write, phone, wire for complete information.

Model E/HS 105, Type 200 is typical of Eastern space-saving design. It supplies hydraulic power to four actuators in a servo mechanism driving missile radar antenna.



Eastern AVIATION PRODUCTS

EASTERN INDUSTRIES, INC.

100 SKIFF ST. • HAMDEN 14, CONN.

West Coast Branch Office: 1608 Centinela Ave., Inglewood 3, Calif.

start-to-finish subsystems for missiles

HYDRAULIC POWER • ELECTRONIC COOLING • REFRIGERATION-TYPE COOLING • PRESSURIZATION-DEHYDRATION

Smooth, quiet power transmission for heavy loads—

The Herringbone gear design provides continuous tooth action — eliminates end thrust.

Built for heavy load conditions, Horsburgh & Scott Herringbone Speed Reducers give you dependable economical service. They're available in single, double and triple reduction units. Check these 9 points of superiority:

1. Overall design conforms to AGMA specifications.
2. All bearing loads are balanced, due to the symmetrical design of the gearing.
3. Oversize bearings and low speed shaft provide tremendous overhung load capacity.
4. Heavy wall and base-pad thickness provides extra housing rigidity.
5. Housing designed with box-type construction for maximum thermal capacity.
6. Every gear is accurately sized and then cut on a modern Sykes continuous tooth gear generator.
7. All pinions are integral with the shafts and are made of heat treated alloy forgings.
8. Dust and oil-proof seals are provided on shafts extending outside the housing.
9. Splash lubrication floods all bearings and gears

You'll find a wealth of information in our Catalog 55 describing our complete line of Speed Reducers. Write for it, or ask your nearby H & S representative.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue
Cleveland 14, Ohio

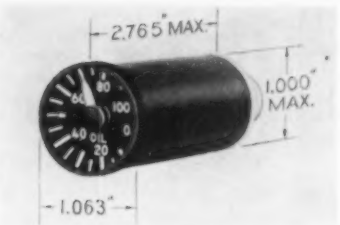
500-F exposure and exhibits almost no cold flow. Applicable as coaxial insulation, and various dielectric machined parts. Machining properties of the rods and sheets are said to be excellent. **Emerson & Cuming Inc, 869 Washington St, Canton, Mass.**

Circle 18, Reader Service Card

Hammered metal finish . . .

with three-dimensional characteristics is said to offer pattern consistency that practically eliminates rejects caused by texture variation. One-coat finish is offered in a wide range of brilliant colors. Can be applied by any spray method to all production metals, many plastics, wood, ceramics and other materials. Air or bake drying is recommended for durability, high corrosion resistance and top gloss and color retention. **Universal Paint & Varnish Inc, Bedford, Ohio.**

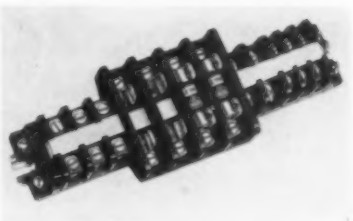
Circle 19, Reader Service Card



Miniature 1-in. indicator . . .

is integrally lighted and meets applicable military specifications. Model is filled with inert gas and hermetically sealed. For use in ambient temperatures of —65 to 160 F. Rotor input is 26 v, 400 cps, stator output is 11.8 v, 400 cps. Input to lamps is 5 v, 400 cps. Designed for remotely indicating jet engine oil pressure, but can be adapted to any type of indicator function. **Avionic Div, John Oster Mfg Co, 1 Main St, Racine, Wis.**

Circle 20, Reader Service Card



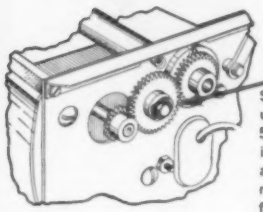
Fusible terminal block . . .

for use where fuse protection is required for solenoids and other single or three-phase loads. Rated 30 amp, 600 v, block will accept any ferrule-type fuse, $\frac{13}{32}$ in. dia x $1\frac{1}{2}$ in. long. Block is composed of in-

(Continued on page 126)

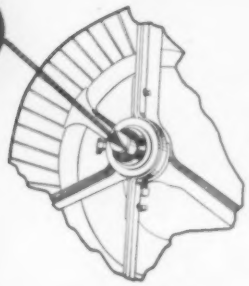
Truarc Rings Eliminate Parts and Machining, Speed Assembly, Reduce Manufacturing Costs

Ring eliminates nut and threading, saves $365/M

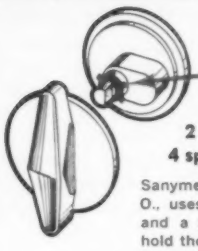


Sanborn Co., Waltham, Mass., uses a Waldes Truarc Series 5555 Grip ring* to secure the idler gear assembly of its portable electrocardiograph. The ring assures faultless gear performance necessary for diagnostic accuracy, eliminates a nut and threading operation for savings of $365 per 1000 units.

Ring saves parts, speeds assembly for savings of $260/M



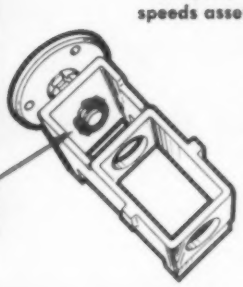
Fraser and Johnston Co., San Francisco, Calif., uses a Series 5555 Grip ring* to secure the fan shaft and speed assembly of its furnace blowers. The ring eliminates a collar and set screw for savings of $180/M on materials, $80/M on assembly time—a total of $260 per 1000 units.



2 standard rings replace 4 special parts, save $170/M

Sanymetal Products Co., Inc., Cleveland, O., uses a Series 5005 Self-locking ring and a Series 5103 Crescent® ring* to hold the escutcheon plate and handle of this doorlatch for toilet compartments. The two standard rings replace four expensive chrome-plated brass parts for savings of $170 per 1000 units.

Ring replaces spring and washer; speeds assembly 50%, saves $15/M



Allen-Bradley Co., Milwaukee, Wisc., uses a Series 5139 Prong-Lock ring* to secure the adjustment knob of its pneumatic timer. Ring eliminates a costly coil spring and washer, simplifies a tough assembly operation. Cost saving: $15 per 1000 units. Assembly time saving: 50%.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

Statistically Controlled Quality from raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today .. let our Truarc engineers help you solve design, assembly and production problems . . . without obligation. e-2

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N.Y.

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me your new 24-page Catalog No. RR 10-58 with descriptions and illustrations of the complete line of Truarc retaining rings, pliers and accessory tools and 80 typical applications.

(please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

PN-120

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*Covered by one or more of the following patents: Nos. 2,382,948; 2,491,306; 2,574,034; 2,755,698.

10 to 100 times the wear resistance of other dry bearings

Comparative Thrust Washer† Performance

Type of Material	Mean Testing Time	Reason for Stopping
DU Composite	1000 hrs.	Completed 1000 hrs.
T.F.E. in porous Bronze	213 hrs.	.005" wear
Graphite & Lead Bronze	158 hrs.	.010" wear
T.F.E. + 25% Graphite	134 hrs.	.005" wear
Oil impregnated Bronze	105 hrs.	.010" wear
Phenolic resin + MoS_2	73 hrs.	.005" wear
T.F.E. + 25% Glass fibre	48 hrs.	.005" wear
MoS_2 Treated Steel	26 hrs.	Seizure
Graphite (bearing grade)	24 hrs.	.005" wear
Porous Bronze + MoS_2	17 hrs.	.005" wear
Asbestos + resin + MoS_2	0.8 hrs.	.005" wear
Nylon	0.3 hrs.	.010" wear

†*Thrust Washers used for comparative tests as most indicative of true relationship of values, since clearances do not enter into their performance.*

*TEFLON, *Du Pont Trademark*
FLUON, *I.C.I. Trademark*

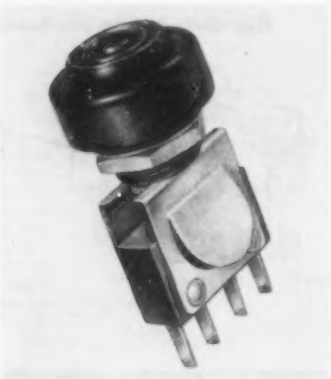
Compare performance and you will agree that DU—the steel-backed porous-bronze bearing with solid T.F.E.* fluorocarbon resin-lead lubricant—offers an entirely new conception of dry bearing service.
Consider its high compressive strength with no cold flow (up to 23 tons per sq. in.)—its extremely low friction with no slip-stick characteristics—its equally efficient performance at temperatures from −320° F to +536° F—its immunity to solvents, detergents, alkalies, corrosive chemicals, abrasive atmospheres—and you will find the answer to many difficult bearing problems where conventional lubrication is impractical or undesirable.
Ask your bearing manufacturer or write for engineering brochure to

SPECIAL PRODUCTS DEPT.
United States Gasket Co.
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

dividual sections assembled on a mounting channel with a clamp at each end. Can be combined with four different types of terminal blocks. Available in factory-assembled units or in kit form. **Square D Co, 4041 N Richards St, Milwaukee 12.**

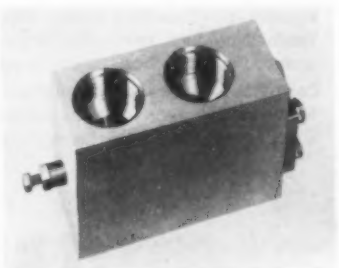
Circle 21, Reader Service Card



Oil-tight pushbutton switch . . .

is said to reduce panel space requirements by 75% and to cost ¼ less than comparable switches. Switch with double break contacts is rated at 10 amp, 125 or 250 v ac or 30 v dc inductive. Button mechanism is sealed neoprene. Integral O-ring seals bushing to panel. Switch is clipped to panel-mounted button after wiring. Anodized aluminum button assembly is available in seven standard colors. Standard terminals include solder, screw and AMP taper tab types, each offered in single-pole through four-pole assemblies for multiple circuit. **Licon Switch & Control Div, Illinois Tool Works, 6606 W Dakin St, Chicago 34.**

Circle 22, Reader Service Card



Spring-loaded check valve . . .

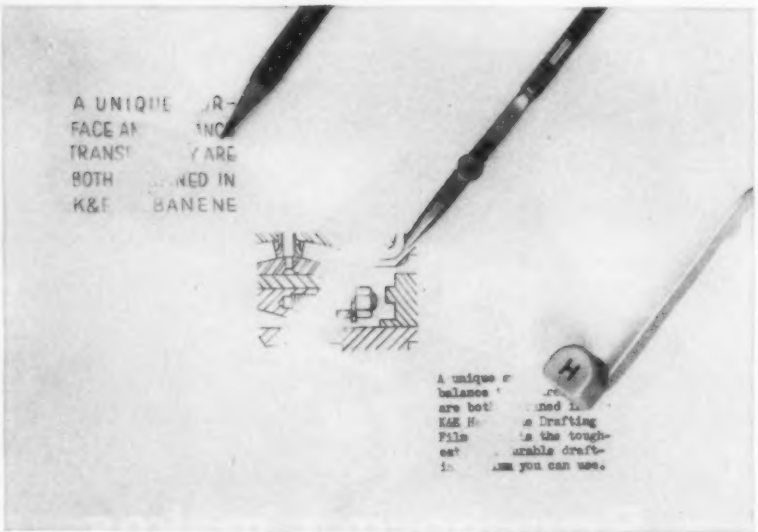
requires low mechanical force to unload. Provides positive control of systems in applications where fast, safe response is required. Permits free flow in one direction and checks reverse flow until it is unloaded by depressing external plunger. Requires 100-lb max pressure to unload with 3000 psi on checked flow part.

(Continued on page 129)

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.



Now you see it . . . now you don't. Pencil, ink and typing all register sharply, erase completely on the K&E "engineered surface."

The K&E "Engineered Surface"

All K&E paper, cloth and film has one extremely individual characteristic. It's what K&E calls its "engineered surface"... a unique surface designed and applied by K&E, right in its own plant, to every roll and sheet of prepared tracing paper, cloth and film. It means controlled drafting qualities far beyond anything the base material alone can normally provide, with a surface tooth that's exactly right and uniform. Whatever's penciled, inked or typed onto it goes on crisply and sharply . . . shows up clearly and stays that way. Furthermore, the "engineered surface" lets you erase if you want to, easily and quickly and without any of those leftover ghost lines that drive you crazy when they show up in reproductions. And remember, only with K&E do you get all the advantages of an "engineered surface," no matter which paper, cloth or film you're interested in.

About HERCULENE (TM) The Newest of Films

Frankly, we think K&E Herculene Drafting Film is a real discovery. It has all the properties of the K&E "engineered surface" . . . exceptional "take," adhesion and erasability . . . plus the toughness and durability of its Mylar® base. What's the latter? It's a polyester film, developed by DuPont, that's uncommonly strong and virtually indestructible . . . waterproof and almost immune to the effects of age, heat, ultraviolet exposure and handling. With our K&E "engineered surface" added, it becomes K&E Herculene Drafting Film . . . the toughest, most durable drafting medium yet to reach the drafting room. And the surface will last indefinitely, without flaking off or chipping off.

Some Points About Paper...

K&E Albanene® Tracing Paper is the largest selling tracing paper in the world today. Why? Because Albanene is the *only* prepared tracing paper which has an "engineered surface." All other brands depend for their pencil tooth solely on the natural surface texture of the paper itself, which varies from fine to coarse . . . often on the same sheet.

Albanene invariably gives you sharp, clear pencil lines, superb reproductions. It has a solid transparentizer that is chemically stable and can't leak out, ever. This permanent transparentizing means that you'll never get white, opaque spots, even from contact with drafting tape. Try the drafting tape test yourself.

...and its package

And now, all Albanene paper in rolls is packaged in the new square carton for better protection and easier storage. Your rolls stay neat and clean while in use, and the cartons will do double duty in helping you to store finished tracings. In fact, some companies are rearranging their filing systems by using Albanene cartons, which hold large numbers of rolled-up drawings and stack simply and neatly.

Some Facts About Cloth

When you want cloth, think first of K&E Phoenix® Tracing Cloth. Besides the K&E "engineered surface" with the superb "take", adhesion and erasability for pencil, ink or typing, K&E Phoenix has all the advantages of a water-resistant, chemically-inert coating that won't soften even under high heat and won't discolor, become brittle or flake off the base. You can even clean both sides with a damp cloth, without worrying about moisture stains.

And Some Tips On Erasing

All K&E drafting media give you excellent erasability, but there's a right way to erase on each one. On cloth and film, harsh, gritty erasers can destroy the surface. You'll get the best results with plastic erasers, such as the Richard Best "Tad" and the Eberhard Faber "Race Kleen." Moisten them for removing ink and stubborn typing; use them as they are for removing pencil lines. Large areas of ink can be removed completely without damage by using a moist cloth and Bon Ami cleanser. On Albanene, electric erasing machines are fine if used with a soft eraser.

The Choice Is Up To You

When it comes to selecting K&E paper, cloth or film for the job at hand, we have to leave the choice to you. We're not being indecisive . . . it's just that you're the only one who knows the particular problem you have and which product solves it best. But remember . . . K&E has a *complete* line of paper, cloth and film . . . and only K&E puts a special "engineered surface" on all three media to provide a well-balanced, uniform surface suited to the base material.

KEUFFEL & ESSER CO., Dept. PE-12, Hoboken, N. J.

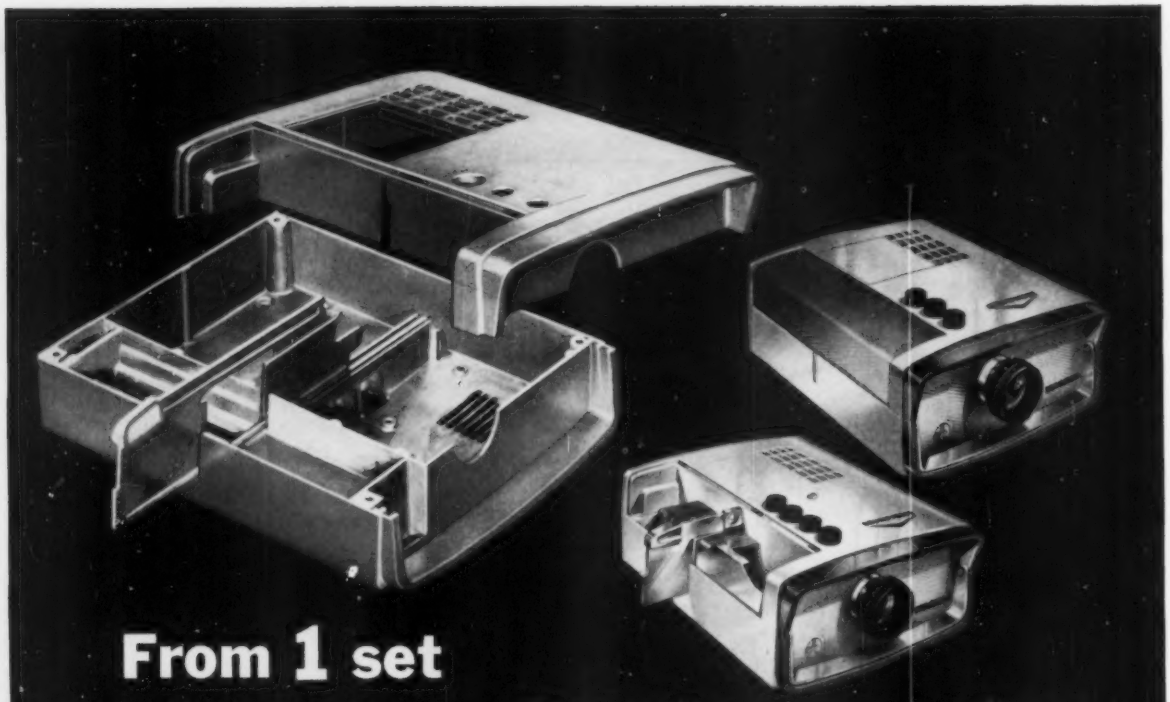
Please send me more information and samples on the following:

☐ K&E Herculene ☐ K&E Albanene ☐ K&E Phoenix

Name & Title_____

Company & Address_____

_____ 1277



From 1 set of die castings Brumberger makes 2 different products

CASE HISTORIES FROM MT. VERNON FILES

If you like to project color transparencies, these two new automatic Brumberger* 35 mm, low silhouette, slide projectors will dazzle you. They are priced much lower than other automatic projectors and eliminate the additional expense of slide magazines and extra carrying case.

These are fine examples of keen engineering perception, for all the inherent advantages of die casting have been applied with those of metal stampings and plastics to produce competitively priced photographic products of outstanding eye appeal and performance.

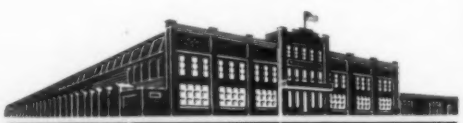
As you can see, these aluminum die castings are intricate. All the necessary slots, channels, pins, gratings, bosses, holes, compartments, handle holes and various recesses are incorporated into the shells so that simple, rapid assembly and minimum finishing operations of the final product result.

Heat from the projection lamp will not warp or weaken the castings, and correct alignment of the optical system is maintained at all times by the thin but rigid, lightweight sections. For Brumberger, die casting has proved to be a supremely advantageous manufacturing method.

More than that, Brumberger has made full use of Mt. Vernons' complete four-fold service: coordinated designing, die making, casting and machining facilities all under one roof in 200,000 square feet of manufacturing space.

And when you plan to make a better product at lower cost by resorting to die castings, we can also give you invaluable help. Just call in your nearest Mt. Vernon sales representative for fast service.

*Brumberger — Brooklyn, N. Y.



MT. VERNON DIE CASTING CORP.
STAMFORD, CONNECTICUT

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

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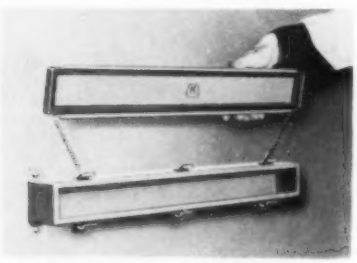
With 25-gpm flow at 3000 psi, pressure drop is 65-psi max in free flow direction and 35-psi max in checked flow position. Zero external leakage and low internal leakage. Valve weighs 3¼ lb. Proof pressure is 4500 psi; burst pressure, 7500 psi. **Fluid Regulators Corp, 313 Gillette St, Painesville, Ohio.**

Circle 23, Reader Service Card

Oil-tight plug-in limit switch . . .

has micrometer adjustment that permits up to ⅛-in. movement of roller position after limit switch has been installed. Accurate adjustments can be made without moving switch itself. Knurled adjusting knob can be marked to assure exact repositioning if switch setting must be changed. Roller operating direction can be changed 90° to allow for cam approach perpendicular to switch base. Can be mounted in any one of six arrangements. Switch requires 5¼ sq in. of mounting space. **Square D Co, 4041 N Richards St, Milwaukee 12.**

Circle 24, Reader Service Card

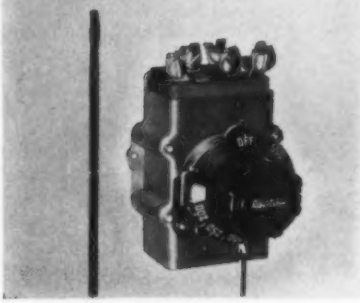


Enclosed wiring troughs . . .

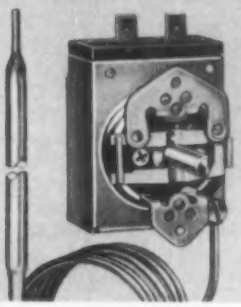
meet JIC electrical specifications and are recommended for installation on machinery, and outdoors wherever protection against oil, dirt, dust and water is required. Removable clamping covers are equipped with positive-sealing neoprene gaskets. Troughs and covers are assembled by semi-hinges on one side and positive-

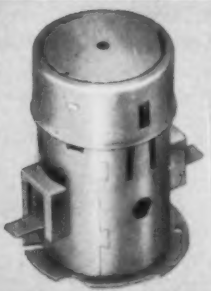
(Continued on page 130)

3-Phase Thermostat—available in various temperature ranges and dial markings. For use with 3-phase circuits on heavy duty electric ranges, sealing machines, etc. In operation, 2 phases keep cycling while the third phase is "on" during the entire operation. In "off" position all three phases are broken.

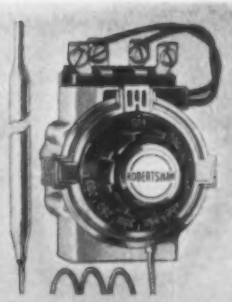


Domestic Appliance Controls for ranges, clothes dryers, air conditioners, room heaters, etc. Low in cost, compact and dependable, with quick response to extremely close temperature differentials. Silver contacts and stainless steel bellows for sustained accuracy.





Combination Fixed-Temperature Control and Switch for restaurant coffee warmers, egg washers, heaters for livestock water tanks and many other applications where a low cost control for maintaining a fixed temperature is required. Eliminates the problem of too much or too little heat.



High Temperature Controls of extreme accuracy and sensitivity for use with temperatures up to 800°F. Either direct or reverse acting types—single and double pole; single and double throw; single and double circuits; with and without limit switches. Corrosion-resistant tubing and bulb.

Unmatched for accurate, trouble-free performance

Robertshaw

ELECTRIC THERMOSTATS AND CONTROLS

Most Complete Line in the Industry. Robertshaw offers the widest variety of thermostats and controls for domestic and industrial use. Available for application in temperature ranges to 800°F.

Unmatched in Quality. Robertshaw's standards of material selection, manufacturing and quality control are second to none in the industry. The result—thermostats that give accurate, trouble-free performance under the most severe usage.

Engineering Assistance is Available. Robertshaw engineers will gladly assist you in application of the proper controls to your appliances or equipment. Laboratories are maintained at Youngwood, Pa.; Irwin, Pa.; Cleveland, Ohio; Long Beach, Calif.; and Anaheim, Calif. Remember, Robertshaw offers you more than 55 years of experience in control recommendations. Take advantage of it.

For information about your particular application write to:

ROBERTSHAW THERMOSTAT DIVISION

Youngwood, Pennsylvania

Robertshaw-Fulton CONTROLS COMPANY

Robertshaw-Fulton Controls (Canada) Ltd., Toronto

BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

pressure screw clamps on the other. Covers are permanently chained to troughs. Made of heavy-gage sheet metal, in four standard sizes (2½, 4, 6 and 8 in. sq) and in length of 1 to 6 ft. **Keystone Mfg Co, 23328 Sherwood Rd, Warren, Mich.**

Circle 25, Reader Service Card

Rigid-vinyl wiring duct . . .

is slotted to speed installation of large lugged wires on control panels, switch gear and electronic consoles. Duct eliminates harness lacing and holds all wires in place with snap-on cover. Duct is extruded from high-impact rigid vinyl plastic that is oil- and acid-resistant and self-extinguishing. May be cut with any hand tool. Standard sizes range from ⅜ x ⅜-in. sections to 4 x 3-in. sections in standard lengths to 12 ft. **Taylor Electric, 15400 Dale, Detroit 23.**

Circle 26, Reader Service Card

Molded plastic blocks . . .

for hand carving or hobbing pre-production samples of injection-molded pieces are said to cost a fraction of sample molding runs and with a saving in time. Prototypes can be prepared for approval and subjected to engineering test runs or use tests. Blocks are offered in most plastics and color can be molded in as desired. Sizes are 16 x 16 x 1, 2, 3 or 4 in., or 8 x 8 x 1¾ in. May be ordered in any quantity. **Cadillac Plastic & Chemical Co, 15111 Second Blvd, Detroit 3.**

Circle 27, Reader Service Card

Solid-state counters . . .

in portable totalizing or predetermined models for laboratory and production control use semiconductor circuitry. Low heat dissipation eliminates need for cooling vents or louvers in the case. Circuit may employ any desired number of decades in series or parallel and for most intermediate speed counting applications. Counters are offered in six standard forms for operation on 115 v ac, 60 cps, less than 25 w or from self-contained battery. Count rates are 500 pps max for totalizing units and 100 pps max for predetermined models. Counters weigh less than 10 lb and 3, 4,

(Continued on page 135)

BIG NAME MACHINE TOOL BUILDERS

SPECIFY

BEAVER BALL SCREWS

TO GET

OPTIMUM POSITIONING ACCURACY

★ BALDWIN LIMA-HAMILTON
★ CINCINNATI MILLING MACH.
★ CLEEREMAN MACHINE TOOL
★ GALLMEYER & LIVINGSTON
★ GIDDINGS & LEWIS MACHINE TOOL
★ HEALD MACHINE
★ KEARNEY & TRECKER
★ PRATT & WHITNEY
★ SPRINGFIELD MACHINE
★ SUNDSTRAND MACHINE TOOL
★ THOMPSON GRINDER
★ WARNER & SWASEY

★ PLUS MANY OTHERS

In head slides, etc., where precision control and maximum system stiffness are essentials, engineers turn to ball screws and to Beaver because they specialize in high precision designs.

Can our engineers help you improve your product?

Largest manufacturers of precision ball screws

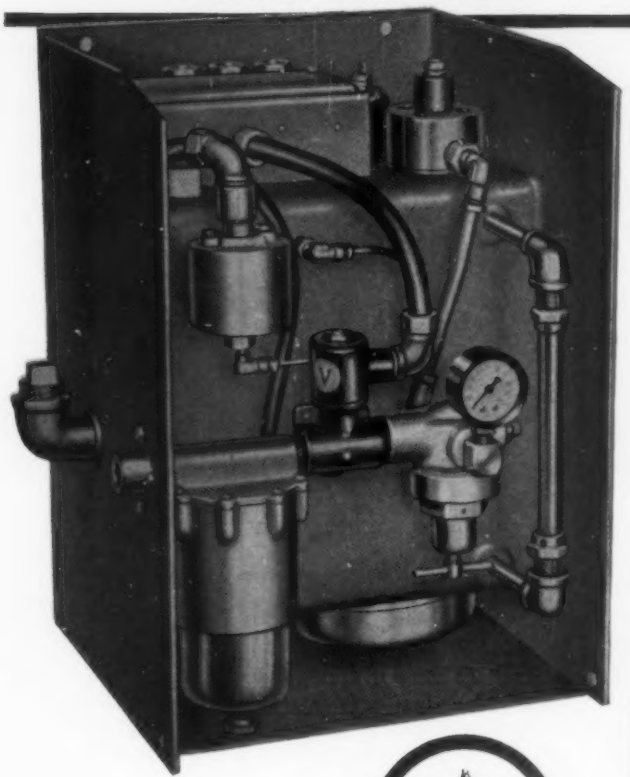
Beaver Precision Products INC.
CLAWSON, MICH.

NOW! An Automatic Lubrication System with

300-500
bearing inch capacity

Oil-Mist Unit atomizes oil and distributes it through tubing to all lubricated mechanisms.

ALEMITE
oil-mist



provides safe–sure–continuous–foolproof lubrication!

- **Large Models Designed for Large Machines!** Designed to lubricate up to 500 Bearing inches. (1 Bearing Inch equals 1 inch of Shaft Diameter.)
- **Big Lubricant Supply!** 3-gallon capacity tank holds enough oil to provide a "48-hour week" of continuous lubrication for 500 Bearing Inches.
- **Extensive Coverage!** System is efficient in small, compact installation or extended over a distance of 480 feet.
- **Multiple Controls!** Automatic controls regulate air pressure, Oil-Mist delivery, check system operation and guard oil level.

Alemite Oil-Mist Lubricates all types of mechanisms

STEWART SW WARNER

ALEMITE
REG. U. S. PAT. OFF.
Division of STEWART-WARNER CORPORATION

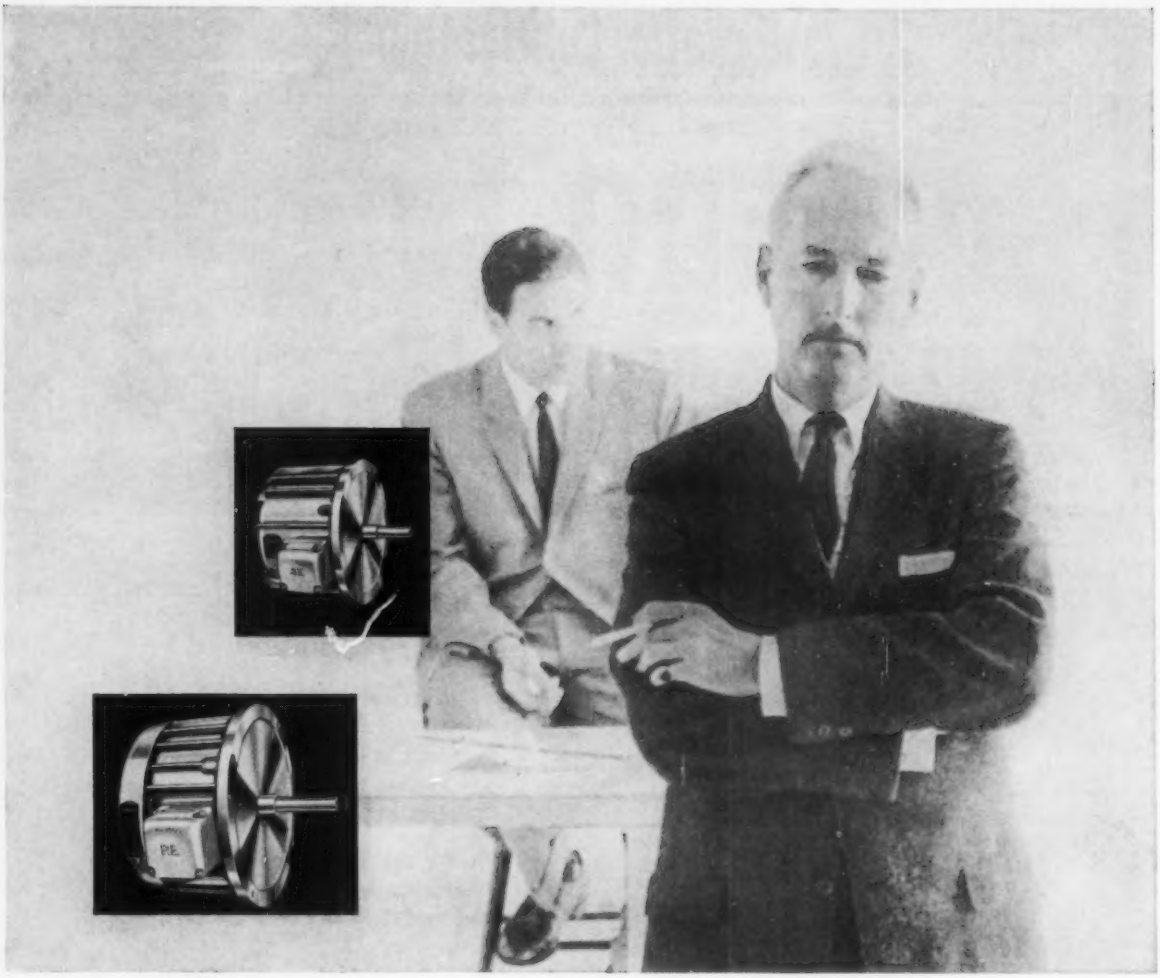
Mail coupon for full details!

Alemite Division of Stewart-Warner, Dept. AA-128
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a FREE copy of your new and complete Alemite Oil-Mist catalog.
☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

Name _____
Title _____
Company _____
Street _____
City _____ State _____

CIRCLE 176 READER SERVICE CARD



WHY DO LEADING MACHINE TOOL DESIGNERS SPECIFY REULAND PRECISION **MACHINE TOOL MOTORS?**

The answer is that these men *know* Reuland Precision Machine Tool Motors are made specially, and only, for machine tool use. Not just another motor that can be "adapted to fit," but a completely new concept that finally achieves the vibrationless operating characteristics so vital to precision machine tool operation.

Dynamic Balancing at our factory tunes every motor to the jewel-like perfection of a fine watch. *Bearings On Each Side Of Rotor* hold it solidly in dynamic position ...lock this true balance in forever once it is achieved. *Radial Air Gap Design* permits the use of a light, narrow, low inertia rotor which, in turn, assures smooth starts and quick stops. The motor's overall length is also reduced to give it a thinner "wafer" effect. *Fin-Type Cast Aluminum Alloy Frames* dissipate heat approximately three times faster than cast iron. *Smooth Castings and Pleasing Lines* are the exterior quality trademarks. All surfaces are specially processed for smoothness and are given a fine, baked enamel finish. This fine-quality finish, together with the motor's naturally pleasing lines, assures a harmonious blend with the lines of every machine tool on which it is mounted. (When desired, the motor's frame size can be varied to fit an *exact* contour of your machine.) *All Heavy Duty Ratings*... ½ h.p. through 10 h.p....are available in totally enclosed fan-cooled and totally enclosed non-ventilated types...either continuous or intermittent duty.

SEE WHAT REULAND CAN DO FOR YOU...by *actually testing* a Reuland Machine Tool Motor on your machine. So sure are we that you will like what you see, we are offering to engineer a demonstration unit to your equipment without the slightest obligation. Just write us.

Our new 8-page brochure "MODERN POWER FOR MODERN-DAY PRODUCTS" will be helpful in your work. Sent free on request.

MODERN POWER FOR MODERN-DAY PRODUCTS

REULAND MOTORS

REULAND ELECTRIC COMPANY
Western Division: Alhambra, Calif.
Eastern Division: Howell, Michigan
Distributors in all principal cities

 CIRCLE 177 READER SERVICE CARD

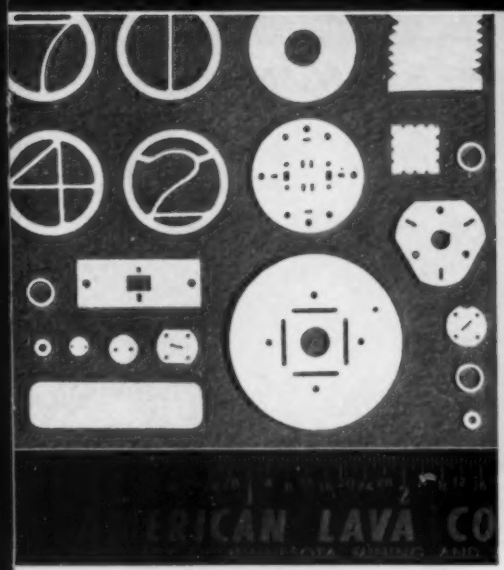
CIRCLE 178 READER SERVICE CARD→

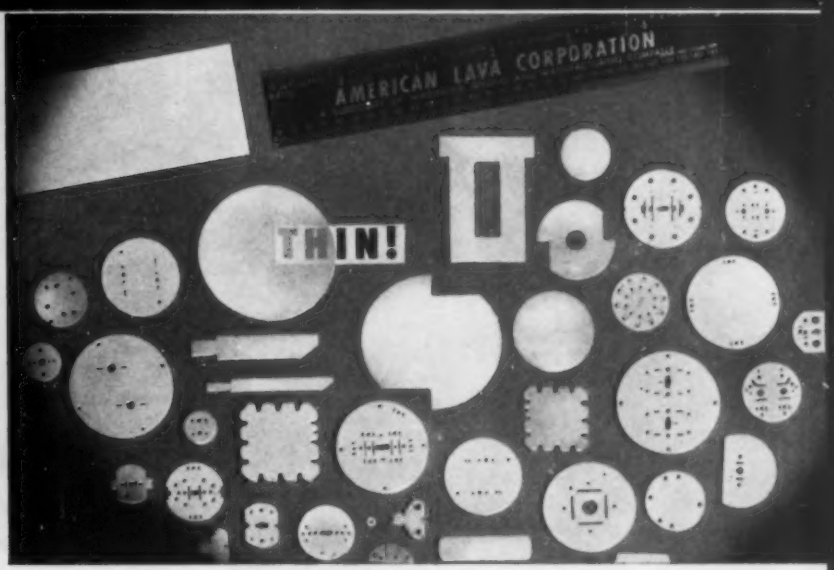
Engineering With Rubber

NEW AlSiMag® THIN CERAMICS!

will these alumina ceramics give you

SMALLER, LIGHTER, MORE RUGGED UNITS?





Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

Free bulletin and typical samples of thin AlSiMag Ceramics sent on request

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

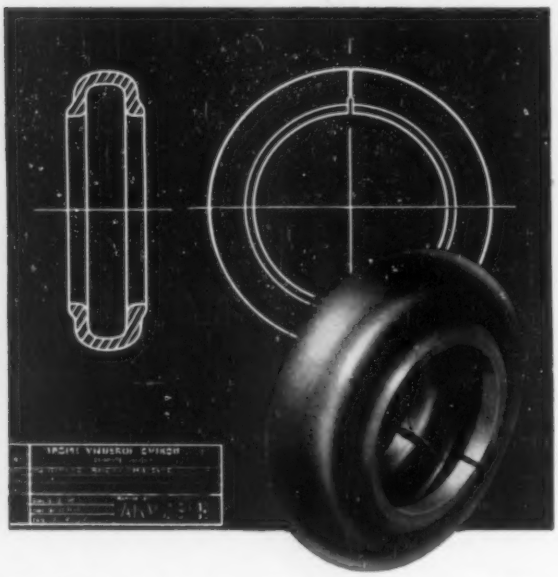
CHATTANOOGA 5, TENN.
57TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

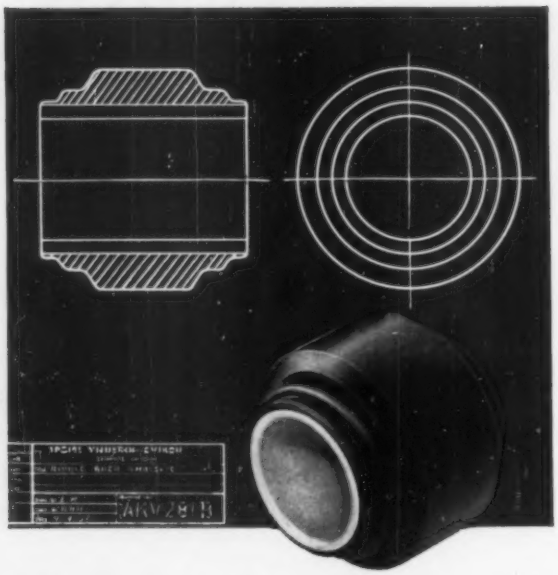
"WIRE CLOTH FABRICATIONS?"

Engineering With Rubber For Improved Performance

These examples show how Dayton molded product engineers are working with mechanical designers to help them achieve new product performance standards. Pre-engineered in combinations of tension, compression and shear for exact deflection requirements, these quality Dayton molded products replace metal-to-metal parts . . . eliminating grease fittings, reducing metal wear and maintenance problems, simplifying assembly, and giving long service.



Rubber tire in this flexible coupling is held by flanges and clamp rings . . . cushions shock loads, reduces torsional vibration, and accommodates angular and parallel misalignment and end float. A transverse split is molded into the tire, permitting replacement without disturbing the shafts. No lubrication is required.



Rubber-to-metal bushing, bonded for life to its inner metal by the quality Dayton process, accommodates torsional and angular motion at the radius rod ends. It provides a flexible pivot joint, eliminating metal wear and lubrication, absorbing shock, noise and vibration. With extreme radial stiffness and maximum torsional flexibility, this bushing is easy to install and can be positioned exactly.

Engineered rubber is the answer to your needs in vibration, noise and shock control . . . inherent misalignment of mechanical elements . . . simplifying assembly problems . . . and reducing maintenance costs. Dayton has design and production facilities to give you complete service from blueprint to finished product. Consult our molded product specialists.

THE DAYTON RUBBER CO., Molded Products Sales Div.
Three Rivers, Michigan

I have a design requirement and would like to talk more about it with one of your sales engineers.

*Name*_____

*Company*_____

*Address*_____

*City & State*_____

RUBBER RUBBER·TO·METAL RUBBER·TO·FABRIC

Dayton Rubber

MOLDED PRODUCTS SALES DIV., Three Rivers, Mich.

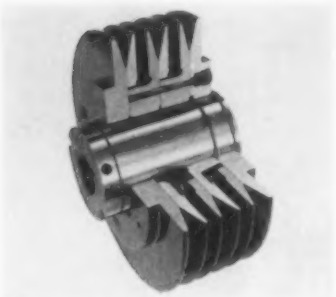
BRANCH SALES OFFICES IN: Dayton, Ohio • Detroit, Michigan Hillside, New Jersey • Atlanta, Georgia • Chicago, Illinois Dallas, Texas • Los Angeles, California

and 5-decade units are 9 x 7 x 6 in. Standard 3-decade units are about $300. 60-day delivery. **Instrument Div, Redford Corp, Lake Luzerne, NY.**

Circle 28, Reader Service Card

Sleeve-bearing motors . . . in NEMA frames 180 and 210 are rated from ½ to 7½ hp. Drip-proof electric motors are recommended where quiet operation is desirable and vibration sometimes associated with ball bearings is to be avoided. Designed also for use with machines where vibration must be held to min to avoid surface imperfections. 5-wk delivery. Priced same as similarly rated ball bearing-equipped motors. **Allis-Chalmers Mfg Co, Milwaukee 1.**

Circle 29, Reader Service Card



Adjustable-speed sheave . . . with stationary control for A, B and C section belts is available in 2, 3 and 4-groove construction. Capacities to 75 hp are covered by 33 sizes. Pitch dia adjustment is made through single adjusting screw and hollow lock screw. Relative position between stationary and movable disks is positively maintained at all pitch dia without disk to main sleeve set screws. Initial and maintenance costs are said to be reduced, as are weights, over-all length and bearing loads. Balance is said to be improved at all pitch diameters. **Allis-Chalmers Mfg Co, Milwaukee 1.**

Circle 30, Reader Service Card

Rotary mechanical stops . . . for predetermined intervals. Dimensionally identical, standard size 10 units con-

(Continued on page 139)

"WIRE CLOTH FABRICATIONS?"

"CALL *Cambridge*"

"You tell us what you need, and we'll have it for you fast—whatever the size or shape"

Roland's right, too. Here at Cambridge he's part of a team that has produced everything from thimble-sized strainers to king-sized dewatering screens, often well ahead of schedule. Whatever your requirements, you're assured of quality workmanship and prompt service when you call Cambridge. And, we'll work from your specifications or draw up prints for your approval.

TO MEET YOUR BULK WIRE CLOTH NEEDS, we have a wide variety of specifications from the finest to the coarsest mesh—in any metal or alloy—in the most frequently used specifications ready for immediate shipment. Individual loom operation and careful inspection just before shipment assures accurate mesh count and uniform mesh size.

Let us quote on your next order for wire cloth. Call your Cambridge Field Engineer listed in the telephone book under "Wire Cloth". Or write direct for FREE 94-PAGE CATALOG and stock list giving the full range of wire cloth available. Describes fabrication facilities and gives useful metallurgical data.

The Cambridge Wire Cloth Company

WIRE CLOTH | METAL-MESH CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

DEPARTMENT P,
CAMBRIDGE 12,
MARYLAND

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Another new fastener idea by Parker-Kalon

SPINNERS?

Screws on the floor mean trouble at your door! Ordinary fasteners when used in the assembly of thin gage metal sheets, often spin or slip—result in work stoppages, salvaging operations, higher production costs.

Now you can substantially reduce waste motion, rejects and lost time, with Parker-Kalon's new "*Hi-thred*" Self-tapping Screw . . . the new fastener that *grips securely without spinning or slipping* . . . even in very thin gage metal sheets.

Developed by P-K's research team, the revolutionary "*Hi-thred*" is THREADED FULL TO THE HEAD—WITH THE LAST THREAD ACTUALLY TERMINATING IN AN ANNULAR ORIFICE IN THE HEAD ITSELF!

For samples, see your nearby Industrial Distributor. "*Hi-thred*" fasteners are available in production quantities *at no increase in price* in Types "A" and "Z" in non-countersunk head styles, in either Slotted or Phillips Recessed Heads.

Keep American Industry at Work! BUY P-K MADE IN U.S.A.

PARKER-KALON® "Hi-thred"

Pat. Pending

Self-tapping Screws

Sold everywhere through leading Industrial Supply Distributors

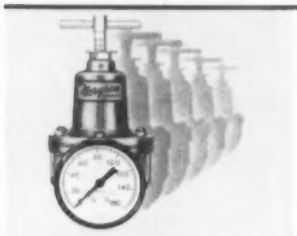
PARKER-KALON DIVISION, *General American Transportation Corporation, Clifton, New Jersey*

"Why it pays to STANDARDIZE on *Norgren*"

The world's most complete line of:

- ★ AIR LINE FILTERS
- ★ PRESSURE REGULATORS
- ★ OIL FOG LUBRICATORS

AIR LINE FILTERS — 98 Models
Automatic or manual drain.



PRESSURE REGULATORS
Over 400 Standard Models
For air, water, oil, steam and non-corrosive gases.

LUBRICATORS — 100 Models
MICRO-FOG for bearings.
MICRO-FOG and Oil-Fog for air-operated devices.

- **One Source for Every Filter, Regulator, Lubricator Need**

  Whatever your requirements may be for air line filters, pressure regulators or lubricators for bearings or air operated devices...Norgren can supply your needs. In Norgren, you have a wide choice of high quality, top performance equipment to meet your specific requirements, plus the advantages of one source...all of which adds up to substantial savings in time and money.

- **International Availability and Service**

  Norgren representatives and stocking distributors are located in 40 of the principal industrial areas in the United States and in 25 foreign countries. When you have a design or maintenance problem, a telephone call to your nearby Norgren representative will bring quick, expert engineering service.

- **Simplified Parts Inventory**

  Extensive interchangeability of parts results in simplified parts inventory.

- **Easier Maintenance**

  Minimize maintenance costs by standardizing on Norgren... the most complete line. Realize the advantages of standardized design and construction features.

If it's Norgren...It's Dependable.

For complete information about any Norgren product...call your nearby Norgren Representative ...or WRITE TO THE FACTORY FOR DESCRIPTIVE LITERATURE.

C. A. NORGREN CO.

3428 SOUTH ELATI STREET — ENGLEWOOD, COLORADO

Reject rate too high?

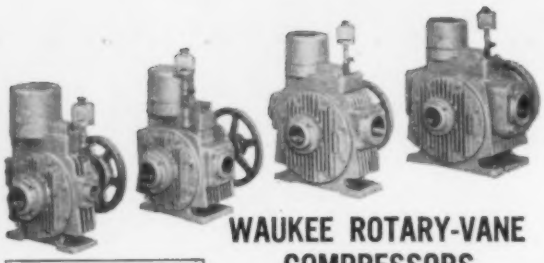
GET THE
MD Metallurgist
IN THE PICTURE

The MD man who calls on you is a competent salesman. He is part of an industry that has grown to serve a significant new technique of manufacture — fabrication of precision parts from powdered metals.

He is backed by a company which, for the past 42 years, has pioneered in the development of the right powders for the right job, and which has always considered that solving customers' problems is a fundamental obligation.

Our laboratory, built and completely equipped for customer service, is staffed by "MD Metallurgists" who have also grown up with the industry, and have contributed to its progress. This "plus value" is always available to MD customers. Your problems are our problems.

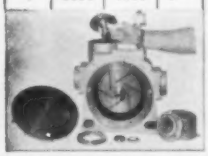
METALS DISINTEGRATING COMPANY, INC.
GENERAL OFFICES: Dept. N, Elizabeth 8, N. J.



WAUKEE ROTARY-VANE COMPRESSORS

with built-in pressure regulator
400 to 6000 CFH at 1 to 3 psi

CAPACITY TABLE			
Model	CFH	Approx. RPM	Motor Size
B	400	650	1/3
C	600	700	1/3
D	750	850	1/3
H	1000	750	1/3
J	1250	850	3/4
E	1500	1050	1
K	2000	750	1
L	2500	900	1 1/2
M	3000	1100	1 1/2
P	4000	700	2
T	5000	850	2
V	6000	1000	3



Waukee Compressor: shows rotor and blades; automatic by-pass regulator piston and diaphragm assembly.

For complete specifications, write for Bulletin 430.

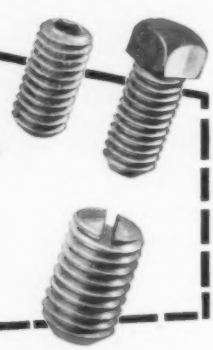
The Waukee Compressor supplies a steady flow of pulsation-free air or gas mixtures at pressures of 1, 2, or 3 psi. Featuring air cooling, rotary-vane construction, and a built-in automatic by-pass regulator, the Waukee Compressor is smooth, quiet and dependable. Also available for vacuum application.

Whether for OEM or replacement use, the Waukee Compressor provides a neat, sturdy, compact installation. Its rotary-vane design has few moving parts; no metal-to-metal contacts. Ball bearings are permanently lubricated with silicone grease. This simple construction means that any good mechanic can service a Waukee Compressor.

Waukee ENGINEERING CO.
5145 N. 35th St. • Milwaukee 9, Wis.
makers of Waukee gas Flo-Meters • Mixors • Washers

CIRCLE 184 READER SERVICE CARD

Set Screws *by the million*



. . . Moore makes them for all types of applications

Whatever you make that requires a set screw . . . standard or special . . . Moore can quickly and economically meet your requirements.

Moore Set Screws are precision made and quality controlled to assure exact uniformity. They fit into mass production assembly techniques; they are of proper hardness for long life; and they have accurate threads for secure locking action.

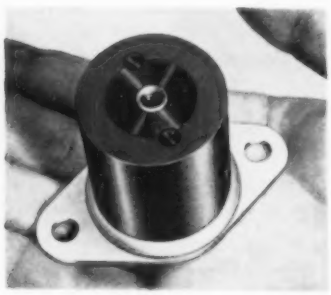
When more set screws are needed think of Moore. Prices are right and you get exceptionally fast delivery. Send for detailed price catalog.

Condensed Specifications			
	Headless Slotted	Square Head	Socket Head
Size dia.	#0 to 3/4"	#6 to 3/8"	#4 to 3/8"
Lengths	1/16 to 3"	3/16 to 2 1/2"	1/8 to 1"
Points	cup, oval, round, flat, cone, dog		
Materials	steel, brass, bronze, stainless, aluminum, alloy steel, monel		
Special Heads — milled, slabbed, double slot, knurled.			
Miniature Headless — #0, #1, #2, #3, #4 sizes in a wide selection of metals, finishes, lengths and points.			

MOORE SET SCREWS
George W. Moore, Inc.
since 1880
92 Beaver St., Waltham 54, Mass.

trol rotary motion in instruments and gear trains. Low inertia mechanisms have low starting friction (0.04 in.-oz max) and high static torque (200 in.-oz min). Standard production stops are available as 15-turn or 30-turn models. Units can be supplied set to angles other than full turns and complete turns ranging from 1 through 30. Accuracy is said to be ±5°. Impact life is estimated at 1500 cycles min at 80 rpm with 26 in.-oz total inertial load. Operates in temperatures of −65.2 to 159.8 F. Stops weigh 1.32 lb each. **Kearfott Co Inc, 1500 Main Ave, Clifton, NJ.**

Circle 31, Reader Service Card



High-strength insulator . . .

consists of two parts, a phenolic insulator body and 16-ga steel cadmium-plated die-formed base. Threaded brass inserts are molded into body. Bodies may be purchased separately from base, if desired. Insulator meets applicable military specifications. **Mullenbach Div, Electric Machinery Mfg Co, 2100 E 27th St, Los Angeles 58.**

Circle 32, Reader Service Card

Isometric gear guide . . .

acts as underlay drawing aid with rack and 21 spur gear faces of 6 to 48 simplified teeth. Has diametral pitches of 8, 12, 16 and 24. Tooth form is based on rack of American Standard 20° involute system. Adaptable to circular forms having evenly spaced projections. May also be used for perspective projection. 11 x 18-in. guide is $1.25. **Graphicraft, PO Box 509, Westport, Conn.**

Circle 33, Reader Service Card

CIRCLE 186 READER SERVICE CARD

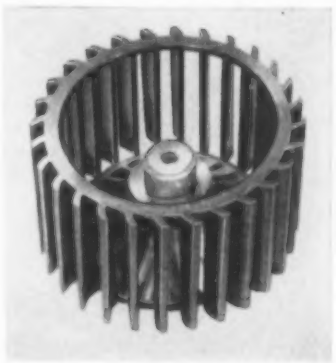
profiles in plastics

By **BARTO L. ATTIG,** *Sales Manager*
AMERICAN INSULATOR CORPORATION
One of The Men Behind The Man From AICO

Most of the men from AICO, the Sales Engineers who serve Aico customers, are recruited from the ranks of skilled technicians within our own organization. Because of their firsthand experience and work in Engineering, Die Making and actual molding of plastics, Aico Representatives are singularly qualified to provide you with the most economical solution to your molded plastics problems. Next time you seek fast, low-cost production of custom molded plastics . . . regardless of molding material, molding method required or quantities involved . . . Talk to A Man From AICO. Aico's unexcelled service, plus coordinated facilities for molding all types of plastics under one roof, saves you time, saves you money . . . eliminates split responsibilities.

AICO MOLDED PLASTICS REPLACE METAL BLOWER WHEELS IN AIR CONDITIONERS

AICO Molded blower wheels now provide manufacturers of air conditioners and heating units with several important production and operating advantages. Blade sections are aerodynamically designed . . . an achievement economically impossible in fabricated metals. Because they're molded to exacting tolerances, precision accuracy is achieved without costly machining and finishing . . . production cost is lowered, assembly time reduced. One-piece construction results in silent operation, higher air delivery efficiency than possible with metal . . . plus dimensional stability in a wide range of temperatures.



FREE PLASTICS DESIGNER'S HANDBOOK

AICO offers you this valuable handbook graphically illustrated and showing how proper design will lower the unit cost of molded plastic parts. Handbook tells and illustrates how costly errors can be avoided when parts are in the design stage. Send for your FREE copy today . . . use coupon below.

AICO'S Nook of Plastics Knowledge

LETTERING

Lettering to be molded on part should be on surfaces parallel to the parting line, sides of characters should be well tapered. Character depth of 1/64-inch is considered adequate . . . depth of 3/64-inch is maximum recommended. Confine lettering to flat surfaces, lettering on curved surfaces requires a split die or complicated die making. Additional information on lettering is fully covered in Aico's Plastics Designer's Handbook. Coupon will bring your FREE COPY.

aico

A completely integrated plastics molding service with unmatched experience and coordinated facilities for Engineering, Mold Building, Compression, Transfer, Plunger, Injection and Cold Molding plus the molding of Reinforced Fiberglas.

AMERICAN INSULATOR CORPORATION
New Freedom, Pa.
Please send me a FREE copy of Aico's PLASTICS DESIGNER'S HANDBOOK.

Name _____

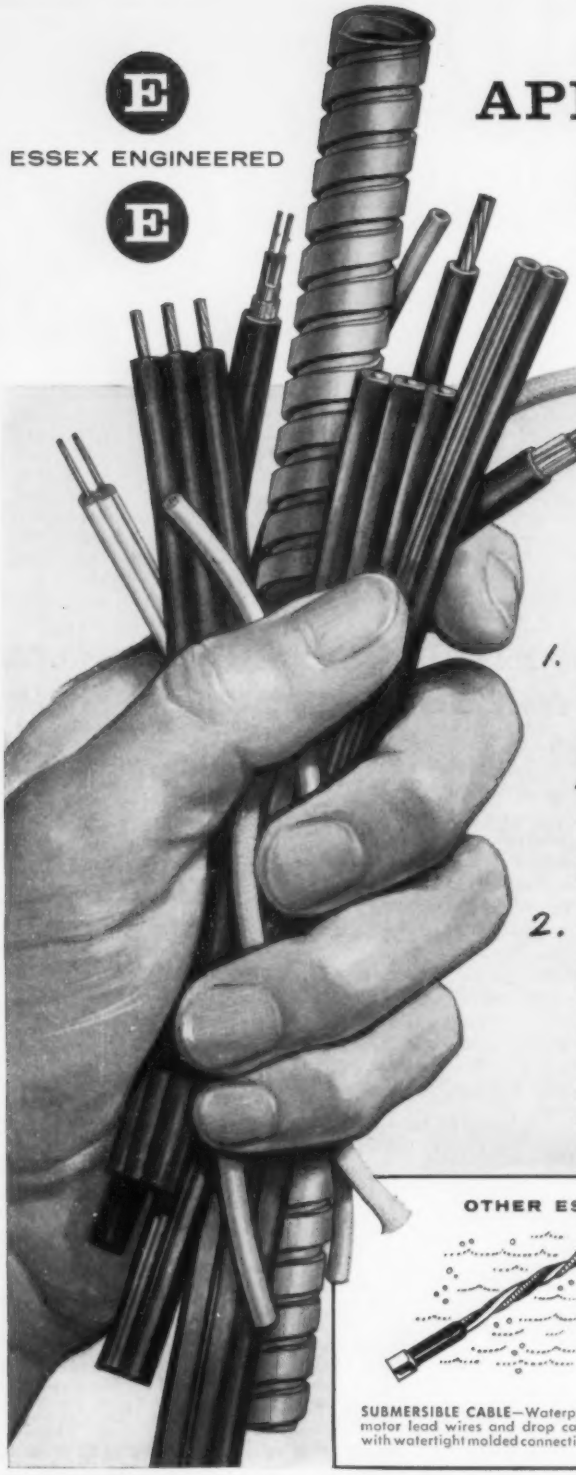
Title _____

Company _____

ESSEX ENGINEERED

APPLIANCE WIRE AND CABLE

Approved by CSA — Bears UL Label



HERE'S HOW ESSEX CAN GIVE YOU A HELPING HAND AND PROBABLY SAVE YOU SOME MONEY, TOO!

1. COMPLETE LINE

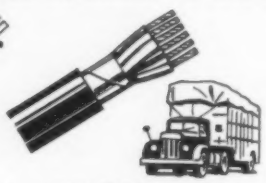
THE FULL ESSEX LINE OF APPLIANCE WIRING MATERIAL... THERMOPLASTIC, RUBBER, NEOPRENE AND SILICONE LEAD WIRE, PLUS INTERNAL REFRIGERATION AND AIR CONDITIONING WIRES, POWER SUPPLY CORDS AND HEATER WIRE...QUICKLY AND ECONOMICALLY MEETS MOST WIRING REQUIREMENTS.

2. APPLICATION ASSISTANCE

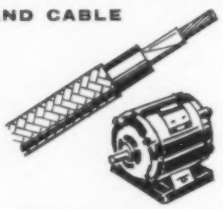
OUT-OF-THE-ORDINARY WIRE OR CABLE SPECIFICATIONS NEED NOT TROUBLE YOU. CONSULT YOUR LOCAL ESSEX APPLICATION ENGINEER FOR THE SOLUTION-OR FOR HELP IN CHOOSING THE ONE BEST TYPE AND SIZE FOR ANY APPLICATION.

OTHER ESSEX ENGINEERED WIRE AND CABLE

SUBMERSIBLE CABLE—Waterproof motor lead wires and drop cables with watertight molded connections.



MOTOPRENE® AUTOMOTIVE CABLE—Thermoplastic..brake cable..rubber covered cord.



MOTOR LEAD WIRE—Rubber, Neoprene or Thermoplastic insulation.

Consult your local Essex Application Engineer or write for complete information

WIRE SX PRODUCTS®

ESSEX WIRE CORPORATION

Wire and Cable Division

FORT WAYNE 6, INDIANA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 145.

THIN-SECTION BALL BEARINGS—Catalog 59, 24 pp. Covers Series T ball bearings. Discusses design principles, and describes and illustrates various types. Includes specifications and typical application data. Split Ballbearing, Div of MPB Inc, Lebanon, NH.

Circle 34, Reader Service Card

SOCKET SCREW PRODUCTS—Catalog 23, 28 pp. Operational principles, sketches and dimensional data. Includes reference tables on thread data and weights, and a self-locking setscrew selector chart. Over 1001 combinations of metals, locking actions, points and suggested applications. Set Screw & Mfg Co, Bartlett, Ill.

Circle 35, Reader Service Card

STOCK TRANSFORMERS—Catalog C-T8-58, 32 pp. Carries listings of over 450 stock transformers with electrical and physical specifications. Performance curves are shown for many units. Chicago Standard Transformer Corp, 3501 W Addison St, Chicago 18.

Circue 36, Reader Service Card

DIESEL ENGINE CONTROLS—Bulletin B45-1, 24 pp. Describes temperature and pressure control systems for diesel engines, safety devices, tachometers, control motors, valves, switches, relays and related accessories. With schematics, photos and dimensional diagrams. Industrial Div, Minneapolis-Honeywell Regulator Co, Wayne & Windrim Aves, Philadelphia 44.

Circle 37, Reader Service Card

RESEARCH, DESIGN AND MANUFACTURING FACILITIES—Brochure, 52 pp. Covers history, organization and complete facilities for engineering, quality control, manufacturing and marketing of hydraulic, pneumatic, electronic and mechanical components. Sargent Engineering Corp, 2533 E 56th St, Huntington Park, Calif.

Circle 38, Reader Service Card

RETAINING RINGS AND ACCESSORY TOOLS—Catalog RR 10-58, 24 pp; Catalog AT 10-58, 16 pp. Selector guides to 20 standard and 30 representative custom rings with brief descriptions of purpose and function of each and, for standard rings, size ranges in inches and millimeters. Second catalog contains engineering dimensions and specs for assembly tools. Waldes Kohinoor Inc, 47-16 Austel Pl, Long Island City 1, NY.

Circle 39, Reader Service Card

FHP ELECTRIC MOTORS—Motor catalog M 159, about 22 pp. Includes specifications, dimensional diagrams and illustrations for about a dozen motors, ranging from 1/1000 to ½ hp. Carter Motor Co, 2773-A W George St, Chicago 18.

Circle 40, Reader Service Card

CEMENTED CARBIDES—Booklet C-16, 32 pp. Includes material that had previously been in five separate publications. Technical section features six special charts on proper feeds, speeds and grades of carbide materials. Simplified pricing system is explained for determination of prices. Allegheny Ludlum Steel Corp, Oliver Bldg, Pittsburgh 22.

Circle 41, Reader Service Card

POWER TRANSMISSION EQUIPMENT—Bulletin 3101, 8 pp. Covers line of sheaves, V-belts, flat-belt pulleys, pillow blocks, flange units, take-up bearings, couplings and timing-belt drives. T B Wood's Sons Co, Chambersburg, Penna.

Circle 42, Reader Service Card

REDUCED-VOLTAGE STARTERS—Bulletin 14B8192, 12 pp. Design and construction features of automatic reduced-voltage starters are described. Carries descriptive copy on theory and operation of low-voltage starters. Covers starting characteristic calculations, hp ratings, features of contactors, relays and fuses. Allis-Chalmers, Milwaukee 1.

Circle 43, Reader Service Card

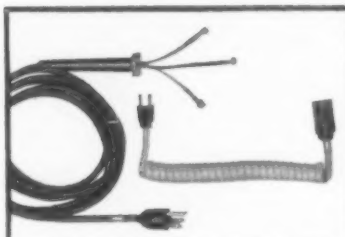
FLEXIBLE-METAL-HOSE CONNECTORS—Catalog 658, 16 pp. Lists standard connectors, with specifications and installation information, installation diagrams and product illustrations. Contains prices for standard models in bronze. Cobra Metal Hose, 5059 S Kedzie Ave, Chicago 32.

Circle 44, Reader Service Card

CONTROL APPLICATIONS FOR POLARIZED RELAYS—Bulletin F-7279, 8 pp. Describes some uses of polarized

(Continued on page 142)

They can be your design assistants on other Essex Engineered Products.



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Prime source for plastic and rubber power supply cords. Terminations of all types (molded plastic and rubber) with infinite design possibilities. Complete line of Coiled Cords including HPN.

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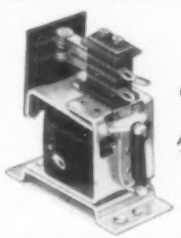

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The basic relay and numerous contact forms, ratings and terminals variations are regular production items...have been "customerized" to solve almost every conceivable problem. Such versatility permits engineering short-cuts that lower your "back door" cost.

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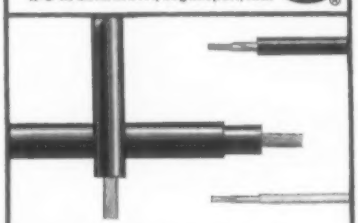

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A complete line of appliance wiring material, radio, television and electronic hook-up wire, 200° C high temperature Sil-X wire, automotive wires and cables, and flexible cords.

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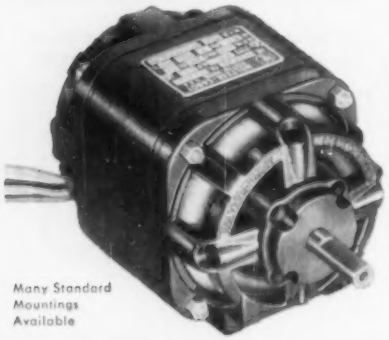
New Designs in Motors from HOLTZER-CABOT



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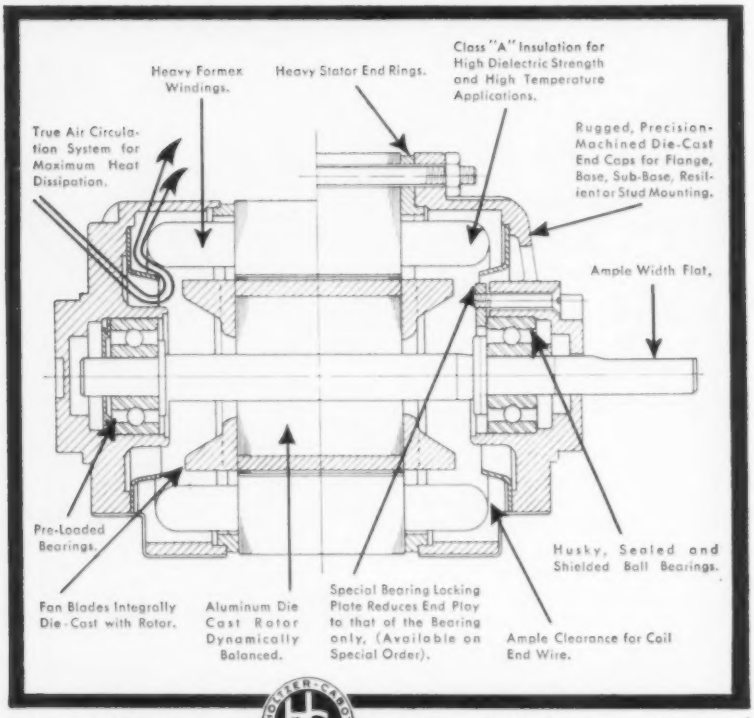
TYPE R-29 MOTOR
2⅞" Diameter

This motor is an ideal power source for recording instruments, timers, medical instruments, office equipment, blowers, tape recorders, communications equipment, etc. It is available in both 2-pole and 4-pole design, each in three stacking lengths. Type R-29 is a permanent split capacitor type available as an induction or synchronous motor. H.P. of various models ranges from 1/75 to 1/30. Construction features are indicated below.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Class "A" Insulation for High Dielectric Strength and High Temperature Applications.
True Air Circulation System for Maximum Heat Dissipation.
Rugged, Precision-Machined Die-Cast End Caps for Flange, Base, Sub-Base, Resilient or Stud Mounting.
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Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

relay, and includes wiring diagrams and photos. Barber-Colman Co, Electrical Components Div, Rockford, Ill.

Circle 45, Reader Service Card

CENTRIFUGAL CASTING—Brochure, 8 pp. Discusses process and advantages in nontechnical terms. Metals and alloys, shapes and sizes that can be centrifugally cast are discussed. Centrifugal Casting Co, 3245 Cherry Ave, Long Beach, Calif.

Circle 46, Reader Service Card

NONELECTRONIC VARIABLE-SPEED DRIVES—Brochures S-790 and S-580, 4 and 8 pp. Covers line of nonelectronic variable-speed drives for industrial equipment motor control. Specs and engineering data for drives from 1/15 to ½ hp. Control arrangements for local, remote, reverse and dynamic braking operations, circuit descriptions and schematics are included. Magnetic Amplifiers Inc, 632 Tinton Ave, New York 55.

Circle 47, Reader Service Card

CONTROL VALVES—Bulletin LB-3, 12 pp. Construction and operating characteristics of Series LB control valve. Describes design features and illustrates construction details by cutaway views, diagrams and cross-section drawings. Optional accessories are illustrated. Conoflow Corp, Dept D-6, 2100 Arch St, Philadelphia 3.

Circle 48, Reader Service Card

SERVOMOTORS—Bulletin 385A, 8 pp. Contains application information for standard and custom servomotors. Includes schematics of servomotors operating direct plate to plate, with transistorized amplifiers and with magnetic amplifiers, characteristics and installation drawings for units in sizes 8 to 23. Norden Div, United Aircraft Corp, Commack, NY.

Circle 49, Reader Service Card

SOLDER TERMINALS—Catalog 158, Section 1, 14 pp. Features specification drawings and dimensional information on terminals, including three new units, designed for molding into plastic headers for use with printed circuits or miniature tube sockets. Alpine Electronic Components Inc, Waterbury, Conn.

Circle 50, Reader Service Card

VINYL-LAMINATED METAL SHEETS AND COILS—Brochures, 8 pp each. Discusses process, advantages, applications and illustrates typical products. Enamelstrip Corp, Allentown, Penna.

Circle 51, Reader Service Card

DIFFERENTIAL PISTON-TYPE RELIEF VALVE—Engineering data sheets 1.721, 1.713, 1.712 and 1.751, 1 pp each. Specs and dimensional data and diagrams

(Continued on page 144)

HOW CHIKSAN HELPS CALM ROUGH SEAS

When Sperry Gyroscope Company developed the Sperry Gyrofin* Ship Stabilizer, their plans called for high pressure hydraulic lines to tilt the stabilizing fins. Flexibility and strength were musts because fins must be tilted fast—in two seconds they must pass through an angle of 35-40°. Chiksan ball-bearing swivel joints provided the answer. These free-turning 360° joints give metal lines the flexibility of rubber, yet deliver burst-proof quality that only steel can provide. This unusual application provides just one example of the problem-solving versatility of Chiksan swivel joints.

Ask for information on Chiksan ball-bearing swivel joints and their many money saving applications on your equipment, and in your plant lines. Over one thousand styles, types, and sizes are available. Write today for the Chiksan General Catalog.

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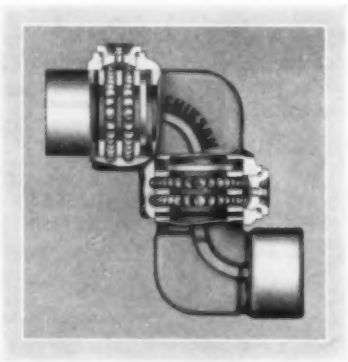
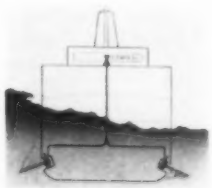
Sperry Gyrofins, incorporating ball-bearing swivel joints in the hydraulic actuating systems, have been in operation aboard the Matson liners Mariposa and Monterey since 1956.





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MEAN BETTER
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In today's miniaturized instrumentation Bird Sapphire and Glass Jewel Bearings show their unique properties to best advantage . . . dry operation through temperature extremes . . . resistance to corrosion fumes and liquids . . . adaptability to special mounting arrangements.

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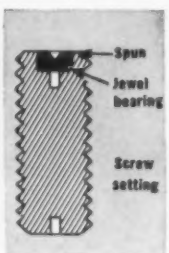
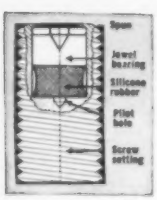
. . . save time and money, cut rejects, keep production flowing smoothly. Special mounting techniques provide assemblies in screws or bushings of any style.



Bird Cushion Jewel Assemblies



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Catalogs and Bulletins . . . . . continued

for various valves in four standard pressure ranges of 100 to 5000 psi. All models are offered in ¼, ⅜, ½, ¾ and 1-in. sizes. Fluid Controls, 1284 N Center St, Mentor, Ohio.

Circle 52, Reader Service Card

TOOL STEELS—Chart, punched and folded for ring binder or for use as a wall chart. Lists comparable brand names of 13 major tool steel suppliers. Classifies by general type and SAE number 16 grades of tool steel. Listed vertically are company brands in each SAE classification; horizontally are brand names available in that grade. Uddeholm Co of America, 155 E 44th St, New York 17.

Circle 53, Reader Service Card

STEPPING MOTORS—Bulletin 958S-M2, 2 pp. Contains performance information, stud and servo mounting variations with dimensions, list of stock models, operating specifications and summary of environmental conditions. G H Leland Inc, 123 Webster St, Dayton 2.

Circle 54, Reader Service Card

AIRCRAFT LOCKNUTS—Bulletin 2426, 4 pp. Text and photos show how locknut meets needs of aircraft and missile designers. Tables compare weights with other locknuts. With installation diagrams, a microphotograph of continuous flow lines throughout forged nut, and graphs of torque vs induced load and tension-fatigue test results. Standard Pressed Steel Co, Jenkintown, Penna.

Circle 55, Reader Service Card

SQUARE-DESIGN CYLINDERS—Catalog sheet, 2 pp. Discusses square-design cylinders and compares them with other types. Sheet contains drawings comparing mounting space required for various cylinders. Miller Fluid Power Div, Flick-Reedy Corp, 2040 N Hawthorne Ave, Melrose Park, Ill.

Circle 56, Reader Service Card

SUBMINIATURE SERVOMECHANISM—Brochure, 4 pp. Describes operation of servomechanism and illustrates basic model, available in kit or assembled form, and several components of kit. Dimensions, operating characteristics and design data are also included. Servo Development Corp, 567 Main St, Westbury, NY.

Circle 57, Reader Service Card

COLOR-CODED THERMOCOUPLE WIRE—Bulletin TC-2, 4 pp. Contains pertinent charts and tables on physical and electrical properties. J Bishop & Co, Malvern, Penna.

Circle 58, Reader Service Card

FLEXIBLE SILICONE RUBBER HEATERS—Catalog sheet C-103, 2 pp.

(Continued on page 145)

Strataflo
SPECIAL
CHECK VALVES
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Submersible
Pumps

SILICONE TREATED
RUBBER POPPET

Tapped one or two holes for attaching Pressure Switch, Pressure Gauge or Snifter Valve.

No. 350

Here's the answer to your Check Valve problems on submersible pumps. The taper-type rubber poppet is noiseless, does not leak, opens easily. Works in any position.

All bronze body. Five sizes, ¾" through 2". May be tapped for one or two side connections as shown. Used as original equipment by many leading pump manufacturers.

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These one-piece fasteners incorporate a "MID-GRIP" self-locking Heli-Coil thread insert with polygon shaped locking coils which meets all military specifications and at the same time offers the advantages of a stainless steel thread to guard against wear, stripping, corrosion, galling and seizing.

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EASY TO INSTALL! NO NUTS, WASHERS OR CLIPS TO LOSE IN ASSY.!

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Easy to install and align.
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No fear of stripping threads.
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Made in light or heavy duty, single or double ended configurations.

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The WSI Fastener eliminates special mounting brackets, clips, nuts, lock washers and wires. Attaches direct to structure, is vibration free, tilts to any angle and is universal in application. Simplifies the part stocking problem.

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- Wire Bundles
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- Floor Panels
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CIRCLE 194 READER SERVICE CARD

Catalogs and Bulletins.....continued

Gives construction features, specs, price and delivery information. Watlow Electric Mfg Co, 1376 Ferguson Ave, St Louis 14.

Circle 59, Reader Service Card

SIDE-MOUNTED MINIATURE CONNECTORS–Bulletin on Series G, 2 pp. Specs, outline dimensions and general information. Electronic Sales Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, NY.

Circle 60, Reader Service Card

SELECTION OF CYLINDERS, TUBING END-SEALS–Data sheets, 2 pp. Lists factors important in selection of power cylinders for specific applications. Discusses safety, fatigue strength of materials, effect of backlash and other factors. Paper appraises and compares various hydraulic tubing end-seals available. Illustrations show five different types. Miller Fluid Power Div, Flick-Reedy Corp, 2040 N Hawthorne Ave, Melrose Park, Ill.

Circle 61, Reader Service Card

SPECIAL STEEL SECTIONS–Folder, 4 pp. Lists several examples of applications, with specs and engineering data. Dept SS, Connors Steel Div, H K Porter Co Inc, PO Box 2562, Birmingham 2, Ala.

Circle 62, Reader Service Card

INDUSTRIAL TEXTILES–Brochure, 6 pp. Illustrates various applications in a number of different industries. Paulsen-Webber Cordage Corp, Industrial Textiles Div, 170 John St, New York 38.

Circle 63, Reader Service Card

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterhead.

FLOW-CONTROL SERVOVALVES–Catalog 220, 6 pp. Descriptions of valves are accompanied by curves on normal flow gain tolerance, load flow-pressure characteristics, typical frequency response and tolerance and nominal coil characteristics. Glossary of pertinent terms is included. Moog Valve Co Inc, Proner Airport, East Aurora, NY.

CARBON AND GRAPHITE PROPERTIES–Catalog 40B, 56 pp. Gives property, application and performance data on carbon and graphite products. Shows how carbon and graphite are made and describe how basic qualities of carbon atom form basis of different grades. Uses are described and illustrated and include mechanical, chemical, electrical and refractory applications. Stackpole Carbon Co, St Marys, Penna.

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Use Vulcan Electric Tubular Heaters when you need considerable heat in confined space: straight or formed in variety of shapes for liquid, gas or metal heating; for casting into iron or aluminum. Threaded fittings are available for liquid immersion heating — water, oil, etc.

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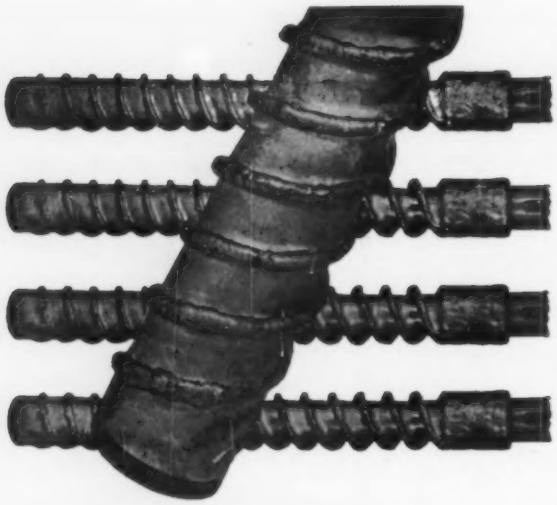
CIRCLE 195 READER SERVICE CARD



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Tests revealed a tremendous increase in the service life of these Colmonoy hard-faced extrusion screws, as against the unprotected screws usually used. Orders for new replacements now specify Colmonoy hard-facing.

Used for extruding plastic, these screws are made of age-hardening nickel-base alloy. This alloy is now readily hard-faced with little loss of hardness, using Colmonoy No. 6 gas rod and a new Colmonoy high temperature flux.

The 60-inch screws have a .050" overlay of Colmonoy No. 6 when finish ground. Colmonoy hard-facing pays for itself in increased life very quickly on expensive parts such as these.

To provide any metal part with longer life, investigate Colmonoy alloys and methods. They represent a complete line of wear resistant alloys and the most up-to-date in hard-facing techniques.

Submit part drawings and a description of the wear encountered for a specific recommendation. Request Hard-Facing Manual No. 79.

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Eliminate Costly Flow Failures

Magnatrol SOLENOID VALVES

Quick Operating *Non Sticking* *Tight Seating*

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory **tested**—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

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CIRCLE 197 READER SERVICE CARD

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WRITE FOR THIS COMPLETE CATALOG!

NO TOOL CHARGE!

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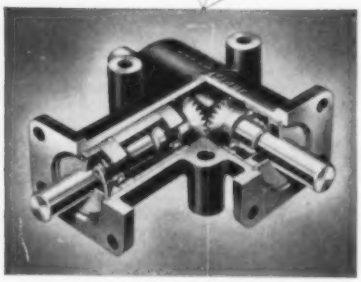
CIRCLE 196 READER SERVICE CARD

CIRCLE 198 READER SERVICE CARD

NEW 2¼ HP
ANGLgear®
HELPS SIMPLIFY
YOUR 90° DRIVE
PROBLEMS



Hardened bevel gears and antifriction bearings insure smooth, trouble-free operation. Completely enclosed, permanently lubricated ANGLgear requires little or no maintenance.

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DESIGN ABSTRACTS

Total Composite Error and Position Error in Gears

Required increased precision in gears has revealed shortcomings in terminology, specification, inspection. Angular positional accuracy as a basis for specification and inspection is growing in importance, as the limitations of total composite error become more widely understood. The nature of position error and total composite error, their relative limitations and applications, are discussed. Information is given for equating position and total composite errors and for their specification.

"Analysis and Comparison of Total Composite Error and Position Error in Gears," G W Michalec, General Precision Laboratory Inc. Presented at semiannual meeting, AGMA, Oct 26-29; AGMA paper 239.07, 1 Thomas Circle, Washington 5, DC.

Effects of an Antiwear Lubricant-additive

A number of the explanations that have been proposed for the mechanisms by which the additive, zinc dialkyl dithiophosphate, has been able to reduce wear in combustion engines are analyzed, and the applications of these concepts to other antiwear materials and wear conditions attempted.

"Some Concepts of the Action of an Antiwear Additive," Twiss, Loeser and Wiquist, Chrysler Corp. Presented at SAE National Fuels and Lubricants Meeting, Nov. 5-6; SAE paper 107D, 485 Lexington Ave, New York 17.

Selecting Plastics

A procedure that selects plastics for particular applications is described, which entails analysis of required mechanical and other properties and characteristics, processing considerations, economics, actual selection of material, and testing of prototypes of the finished product.

"Selecting Plastics to Suit the Application," R L Miller, E I DuPont de Nemours & Co Inc; SPE Journal, Oct '58, 65 Prospect St, Stamford, Conn.

How to Get the Polyethylene You Need

This first of two articles tells how physical properties of polyethylene can be tailored to fit manufacturing process

(Continued on page 149)

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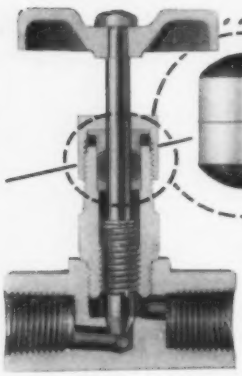

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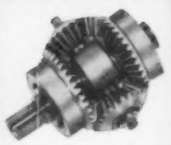

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and actual application, with emphasis on molded materials. Second article deals with film, pipes, coatings and other applications.

"When You Want Polyethylene, Know What You Want," Modern Plastics, Oct '58, 575 Madison Ave, New York 22.

Design Producibility

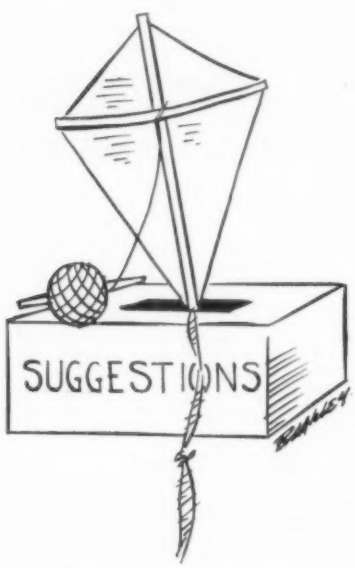
How producibility of given designs may be analyzed is described, according to four basic steps: (1) review of design criteria; (2) analysis of possible designs; (3) evaluation of tests; (4) recommendation.

"Design Producibility of a Magnesium Casting," Krzymowski and Miller, The Martin Co. Presented at 14th annual convention, Magnesium Assn, Oct 16-17, 122 E 42nd St, New York 17.

Correlation Analysis

Curve plotting may be applied to engineering problems when all factors except the two being studied can be held constant, yet there are situations where this is impossible. Correlation analysis—not new, but also not widely used—can be used even where there are several variables. This is done by calculating equations of the most probable line, called the line of regression, and only simple arithmetic is employed—although algebra and calculus are used to establish validity. Several practical applications from actual engineering practice are given.

"Applying Correlation Analysis to Engineering Problems," George Shombert, Allis-Chalmers Electrical Review, 3rd Quarter '58, Milwaukee 1.



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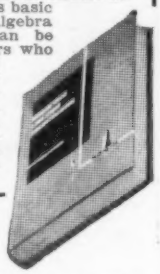

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NEW BOOKS

Table for Solution of Cubic Equations

HERBERT E SALZER, CHARLES H RICHARDS, and ISABELLE ARSHAM. *Published by McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 8 x 6, 161 pp. $7.50.*

Here is a table for the numerical solution of cubic equations having real coefficients, superseding other tables in number of decimal places, range, interval, required labor in finding all three roots, and convenience in use.

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Static-control Industrial Application Manual

General Purpose Control Dept, General Electric Co, Bloomington, Ill. 8½ x 11, 152 pp. $5.

Book covers general-purpose industrial applications. There are sections on fundamentals; electrical and mechanical design; operation of general-purpose control components; circuit design; panel layout including device arrangement; drilling plans and complete wiring diagrams; system checkout procedures on test; troubleshooting; and repair and replacement. Representative static-control applications are included in the publication which also gives detailed ordering information. Static-control components are fully illustrated. Glossary lists all appropriate technical terms.

Principles of Electrical Measurements

H BUCKINGHAM AND E M PRICE. *Philosophical Library Inc, 15 E 40th St, New York 16. 6 x 9, 600 pp. $15.*

This book brings together descriptions of most electrical measuring devices and systems. Includes typical instrument types: moving-coil, moving-iron, electrodynamic induction, electrostatic, thermal, reed, eddy current, damped, deflectional, potentiometer,

(Continued on page 153)

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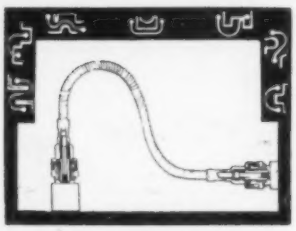

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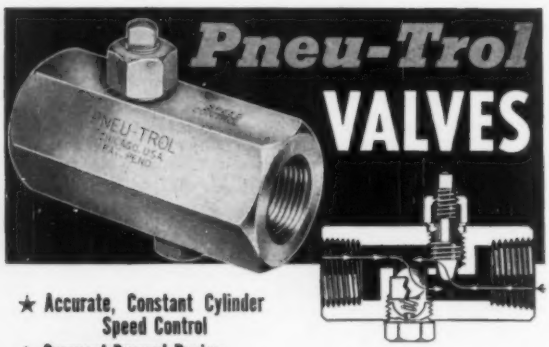

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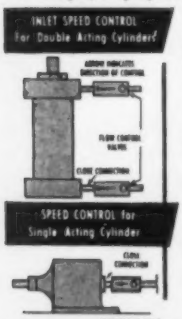

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Metal Statistics for 1958

51st annual edition, American Metal Market Co, 53 W Jackson Blvd, Chicago 4. 4 x 6, hardbound, 848 pp. $3.50.

This plump little annual contains just about every fact and figure anyone could want on prices and production of the major ferrous and nonferrous metals and their ores. It includes a "Buyer's Guide," helpful though incomplete, and a good deal of data on production in other countries as well as the US.

Industrial Electronics Handbook

WILLIAM D COCKRELL. *McGraw-Hill Book Co, 330 W 42nd St, New York 36, 9 x 6, 1408 pp. $22.50.*

This is an unusually complete and practical book, the work of about 100 experienced specialists from more than a score of companies and research centers. It has 10 sections: Fundamentals, Control Elements, Power Supplies, Circuits, Circuit Applications, Instruments, Mechanical Equipment, Users' Requirements, Information on Patents, and Source References.

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(Continued on page 155)

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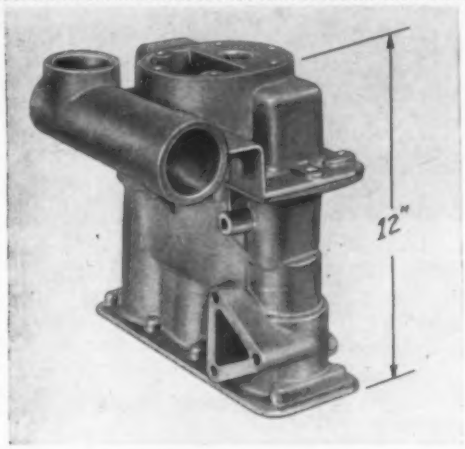

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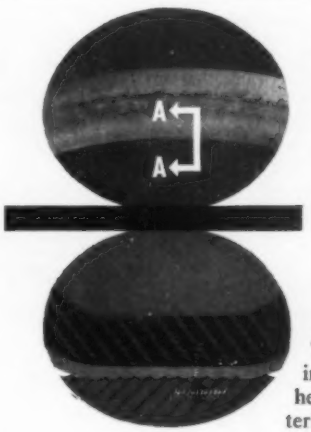

TOP: Tool marks visible in TEFLON coating, magnified 12X.

BOTTOM: Section A-A TEFLON . . . conforms to irregularities in machined surface.

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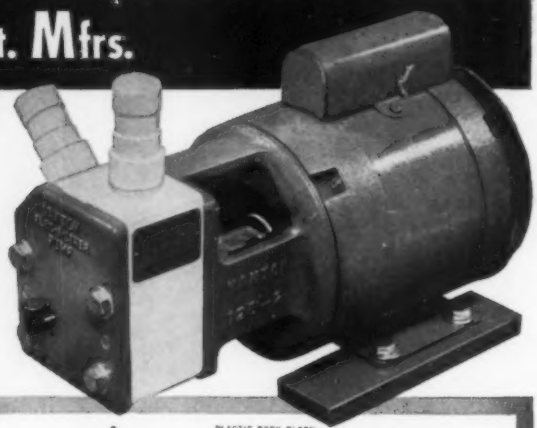

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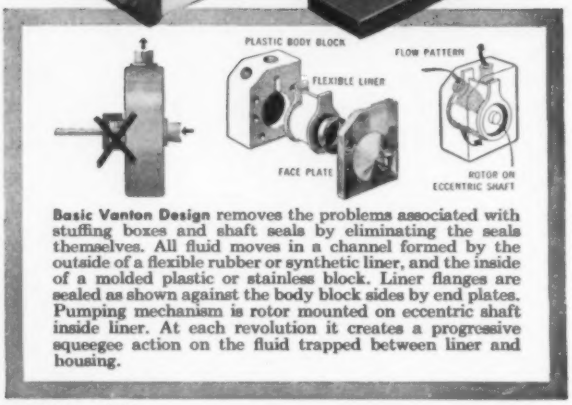

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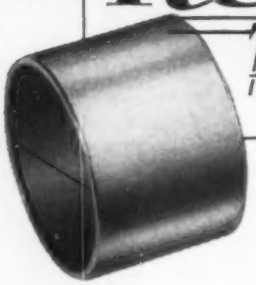

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the related problems in other fields. It shows electrical and electronic graphical symbols, and has numerous tables, including those of logarithms, trigonometric relations, and Laplace transforms. Furthermore, detailed coverage is given for feedback control (with tables and graphs), mechanics, heat transfer, light and optics, and basic electricity.

The remaining sections do a thorough job in summarizing technology in fields of electronics and controls. Among specific subjects covered are computers, regulators, relays, transducers, amplifiers, military and industrial utilizations, Geiger counters, multi-phase power rectifiers, electronic switches, automation, and process control. Parallel discussions of alternate and auxiliary means (such as pneumatic, hydraulic) are included. Newest techniques in the field—such as magnetic amplifiers, logic circuits, transistors, and computer circuits, are discussed by the men who helped develop them. Treatment is also given to mechanical design, including human engineering, testing, field installation, industry and customer preferences, and environmental requirements.

Automatic Process Control

DONALD P ECKMAN. *John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 6 x 9, 368 pp. $9.*

This simplified text starts at the beginning by defining automatic control and includes block diagrams, basic equations, easy-to-read schematics, sketches and tables. It describes typical processes, and gives controller characteristics needed. Closed loop is explained as well as feedback, controlling and final power elements in the system. Mechanical, electrical, hydraulic, pneumatic and electronic devices are described and shown schematically. Transfer functions, stability criteria, process instrumentation, and sinusoidal analysis are treated briefly but will solve most problems commonly encountered.

Trouble-free Hydraulics

IAN McNEIL. *Ronald Press Co, 15 E 26th St, New York 10. 5 x 8, 124 pp. $6.50.*

This is an elementary handbook on maintenance and fault-finding in oil hydraulic machinery. It contains several dozen tables and charts listing

(Continued on page 157)

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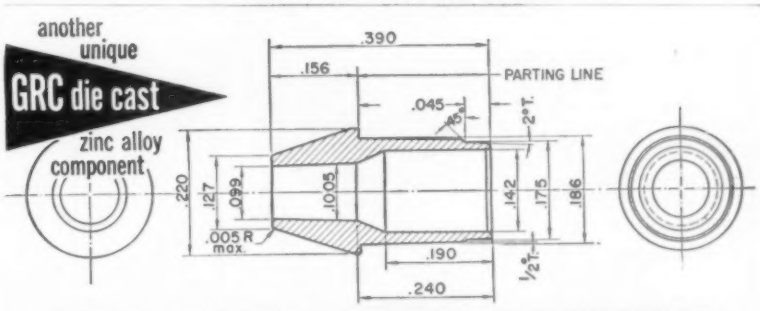

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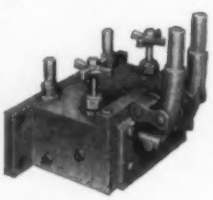

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step-by-step procedures to identify trouble and correct it. Typical table headings are: maximum permissible oil velocities, tensile properties of pipe metals, oil contaminants, viscosity conversion, fire-resistant fluids, seal compatability with oil. Good preliminary reference for engineer new to field.

Computability and Unsolvability

MARTIN DAVIS. *McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 9 x 6, 210 pp. $7.50.*

This is an introduction to the theory of computability and noncomputability, usually referred to as the theory of recursive functions. It is concerned with the existence of purely mechanical procedures for solving various problems.

The first part of the book deals with the general elementary theory of computability. It shows how the concept of computability may be made precise by using Turing's notion of a computing device and how this leads to unsolvable problems. The second part demonstrates how these results may be applied to problems in algebra, number theory, and mathematical logic. Finally, the third part deals with further developments in the general theory of computability.

Special mathematical training is not required on the reader's part. Although the theory is a branch of pure mathematics, it is of potential interest to non-mathematicians because of its relevance to the theory of digital computers and to certain philosophical questions.

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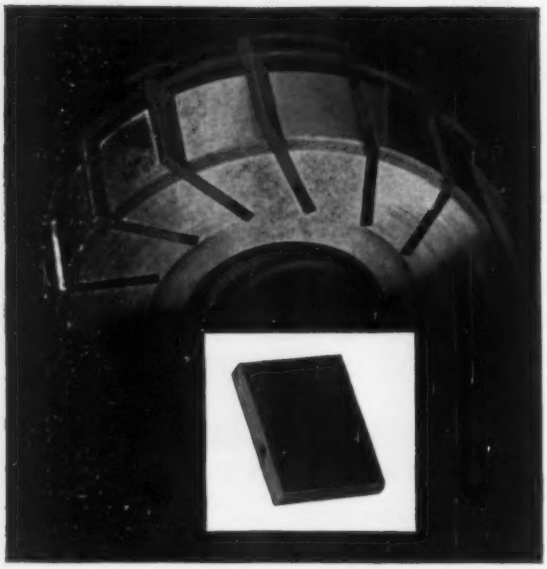

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Porcelain Enamel
New look at wide selection of colors and textured surfaces available. Chart describes enameling processes. Nov 24, '58. *Circle E 51*

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Charts and formulas for determining how far beyond the yield strength you dare go. Sep 29, '58. *Circle E 49*

Springs that Store Energy Best
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Microfilm
How miniaturization of records can solve administrative problems and save design time. Oct. 27, '58. *Circle E 46*

Numerical Control of Machine Tools
How it works: where it's heading. Oct 27, '58. *Circle E 45*

Optical Projectors
How projectors may be used in development, research and laboratory testing. Chart gives limitation and advantages of 30 conditions. Mid-Sep '58. *Circle E 44*

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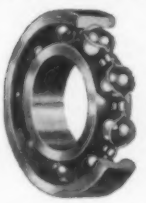

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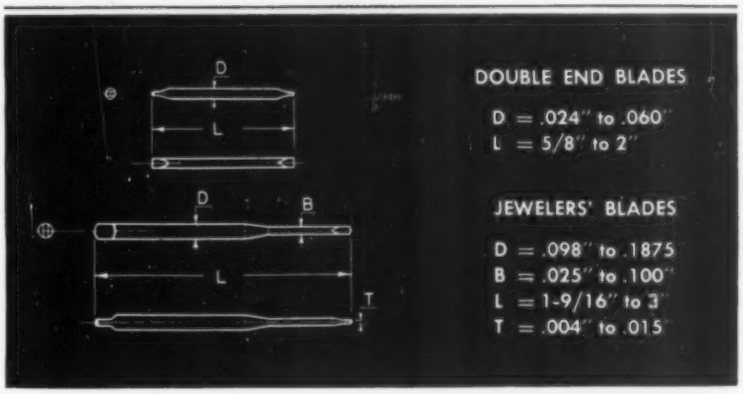
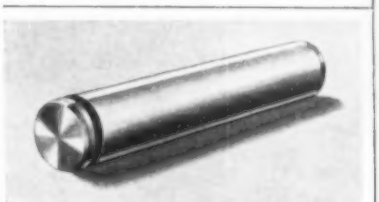
NEWS
from Torrington on
SMALL PRECISION METAL PARTS



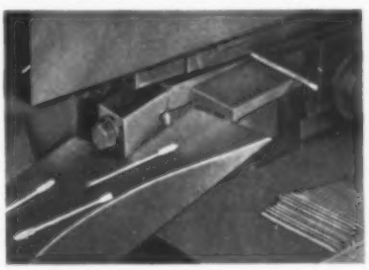
"Custom manufacture" has a special meaning at Torrington, where our Specialties Division produces a tremendous variety of small precision metal parts. For our engineers often help in designing parts for our customers, and as frequently develop special equipment or methods for most efficient production.

For example, one of our current contracts is for jewelers' screwdriver blades. In this case, our engineers decided to swage these parts to give the required high-strength characteristics without stress concentration points and tool marks. Other features of these parts are good dimensional accuracy and closely controlled heat treating for hardness and temper.



In another case, we received a blueprint of a special pinion axle with an accurately cut retaining ring groove at one end. The customer inquired whether this part could be produced at about the same price as a straight cylindrical axle with an uninterrupted OD. The answer was "Yes!" Specialties engineers decided that high-speed cutoff and groove-turning equipment would have to be built to cope with the high volume involved. Special pinion axles have now joined the great number of parts being produced by Torrington Specialties Division.

Whatever the part, whatever the operation—even operations tailored to the part requirements—Torrington's Specialties Division is uniquely equipped to handle your small precision parts contracts. Highly specialized fluting operations, for example, permit volume production to close tolerances. Precision swaging, knurling, forming, milling, drilling are among other operations for which we are fully equipped. Advanced heat treat and statistical quality control methods help provide the quality product you require.



For help with your custom-built small precision metal parts in large quantities, just circle our number on the reply card. Or have your Purchasing Agent call our area salesman, or write direct to:

The Torrington Company, Specialties Division, 230 Field Street, Torrington, Conn.

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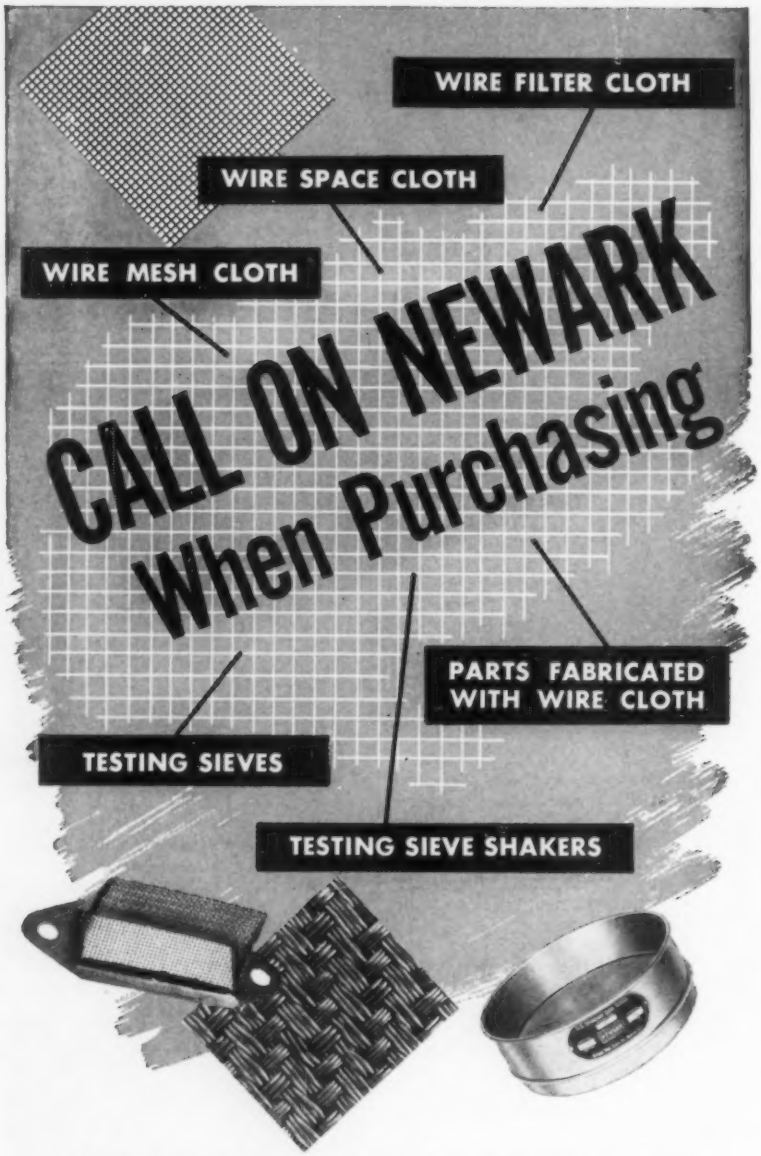

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351 VERONA AVENUE • NEWARK 4, NEW JERSEY

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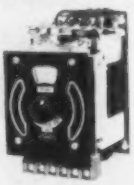
NEW DEVELOPMENTS IN

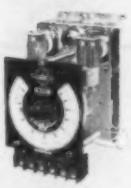
atc® TIMING CONTROL

MISSILE TIMERS

ATCOTROL MINIATURE RESET TIMERS



VERNIER SET AND CYCLE PROGRESS TIMERS



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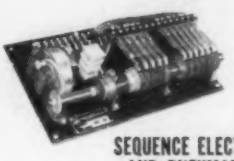

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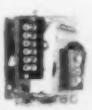

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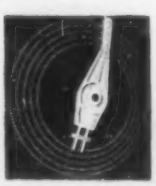

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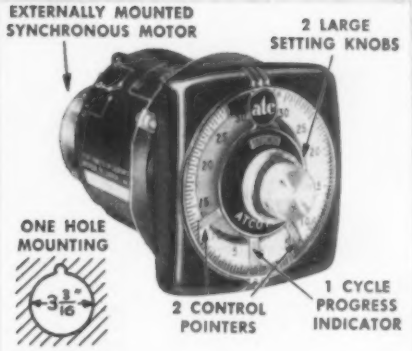

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Designed to control two separate circuits consecutively, the Atcotrol Duo-Set is a miniature masterpiece of simplicity, accuracy (¼% of scale) and dependability.

It embodies features usually obtained only in highest priced timers. For example, the motor reverses to change direction of the cycle progress pointer. This permits change in control point setting during the cycle and eliminates excessive mechanical parts. Load contacts are rated at 10 amps, 115 volts.

Duo-Set Timers incorporate all the service-proved features of the Atcotrol design . . . easily mounted, quickly removed for inspection while operating, self-cleaning contacts, fully protected one-piece compression molded terminal block and one-piece tubular rolled laminate slip-off cover.

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15, 30, 60, 120, 240 minutes

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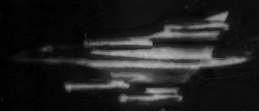

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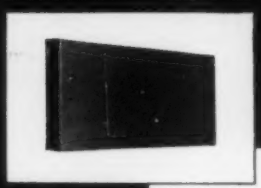

High performance vanes for miniature aircraft pumps and jet engine fuel pumps

Radar contacts and other electronic parts withstand continuous rugged service

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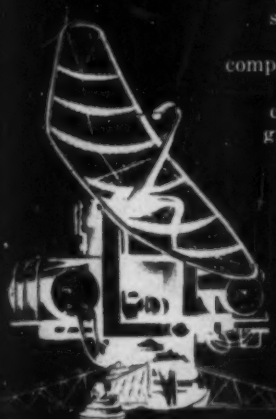
Morganite components provide complete reliability in many types of airborne equipment. Morganite will not warp, stick or gum, is self-lubricating, non-contaminating. These dependable components function in high temperature and pressures and are unaffected by corrosive chemicals, oil, water, gases, grime . . . the standard of performance on process equipment, compressors, meters, pipe line and general industrial machinery.



For trouble-free operation — Install Morganite bearings, seal noses, pistons, piston rings, rod packings, gland rings, slides, valves and special parts. Call or write today for recommendations on specific applications.

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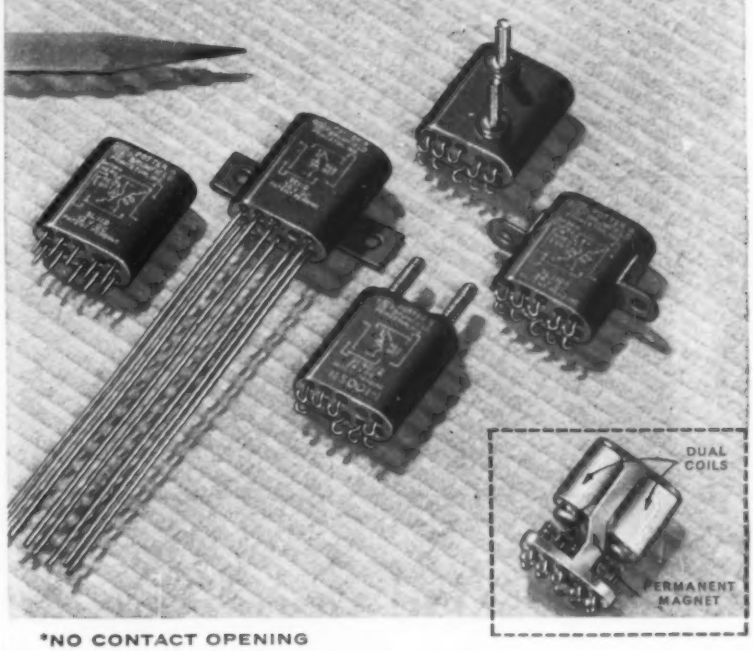
P&B MICRO-MINIATURE RELAYS LEAD IN

performance

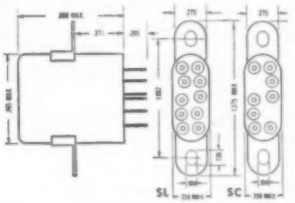
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 230 mw, 3 ms. pulse at 25° C. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 260 mw at 25° C. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g. for 11 ms.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC.)
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.
CONTACTS:
Arrangement: 2 Form C.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.
COIL:
Power: SL—230 mw @ 25° C.
SC—260 mw @ 25° C.
Resistance: SL—10,000 ohms per coil max.
SC—20,000 ohms max.
Duty: Continuous.
MOUNTINGS:
Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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Weldynamics

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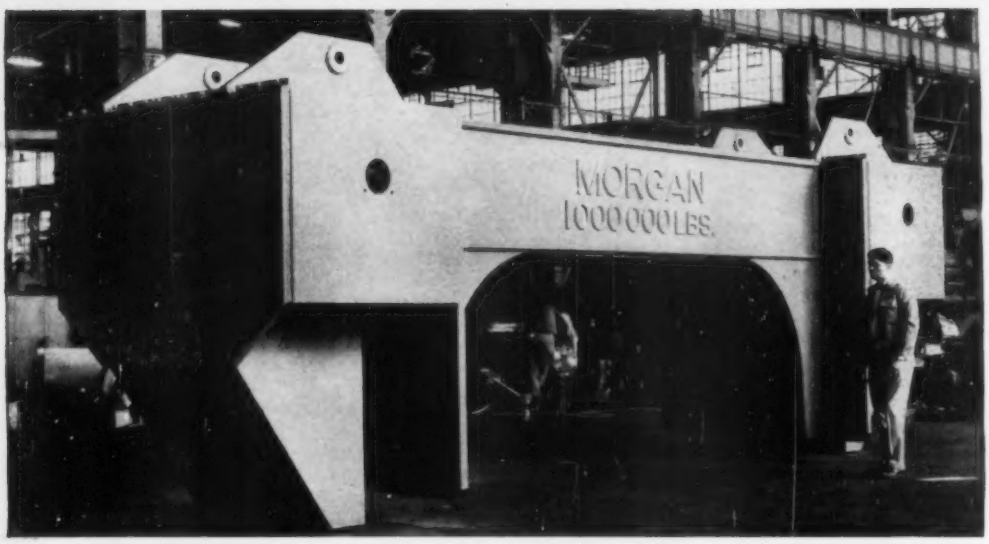

All-Welded Lifting Beam for 500-ton hot metal ladle crane

More strength—less weight for world's largest ladle crane . . . *welded design does it for less money*

Maintaining highest possible strength with a minimum of weight is the prime objective in cranes like this. That's why welded construction is chosen.

Actually, 25% less steel is needed by welding these heavy cranes. This means material and fabricating costs are substantially lower. In addition, the crane is more maneuverable, availability higher, upkeep costs are lower.

Why not duplicate these benefits in your products now? Write us to show you how.

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> The prime objective was to accomplish the highest possible pay load with assurance of uniform stress conditions and uniform material throughout with a minimum of weight at the lowest possible cost. These objectives were achieved by the extensive use of welded design throughout.
>
> C. F. SIMMERS, Vice President, Engineering
> The Morgan Engineering Co.

The World's Largest Manufacturer of Arc Welding Equipment

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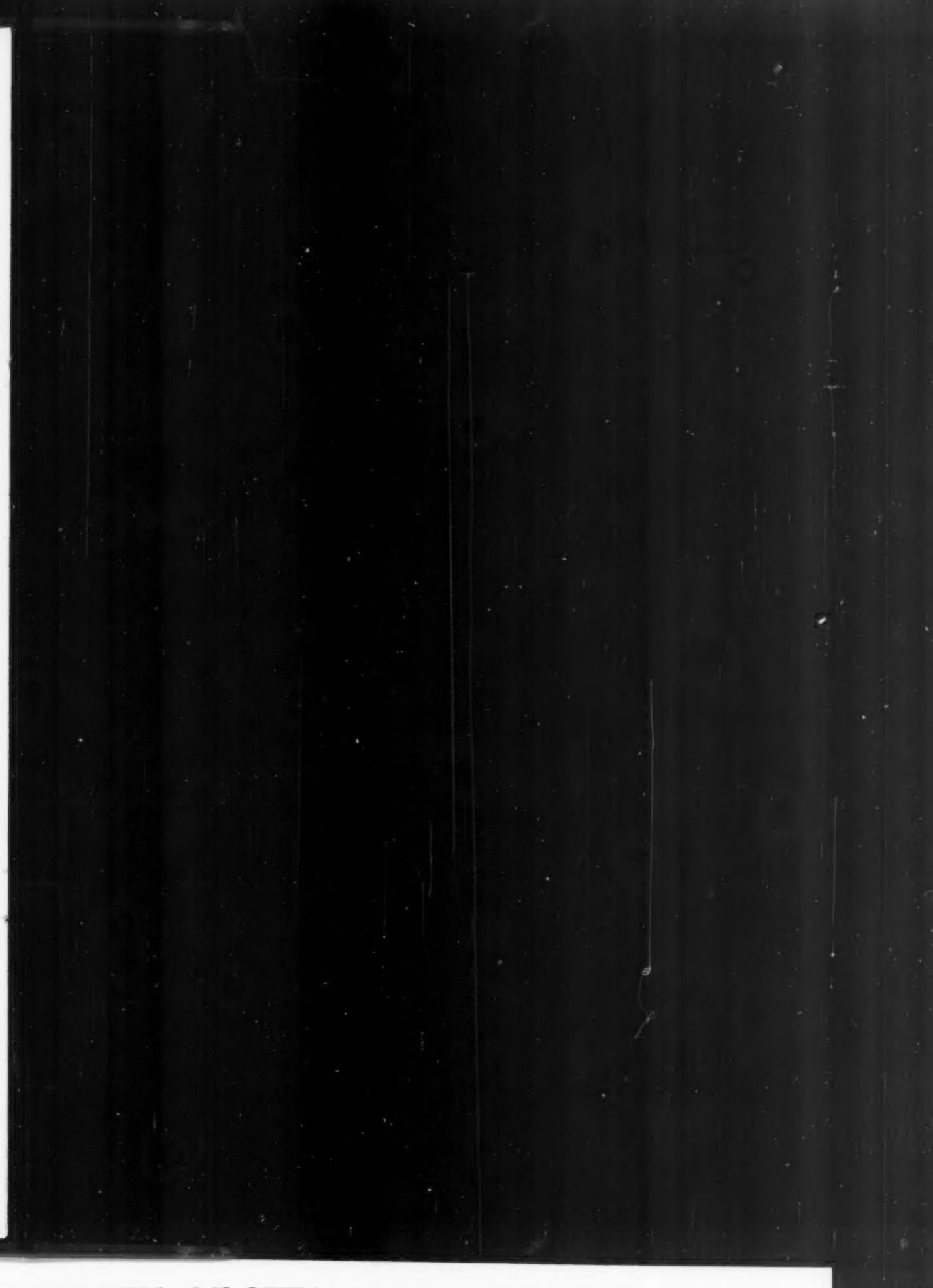

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54—Stepping Motors, 2 pp, G H Leland Inc.
57—Subminiature Servomechanism, 4 pp, Servo Development Corp.

ELECTRICAL, ELECTRONIC COMPONENTS

36—Stock Transformers, 32 pp, Chicago Standard Transformer Corp.
43—Reduced-voltage Straters, 12 pp, Allis-Chalmers.
45—Control Applications for Polarized Relays, 8 pp, Barber-Colman Co.
50—Solder Terminals, 14 pp, Alpine Electronic Components Inc.
58—Color-coded Thermocouple Wire, 4 pp, J Bishop & Co.
60—Side-mounted Miniature Connectors, 2 pp, Sales Div, DeJur-Amsco Corp.

HYDRAULIC, PNEUMATIC EQUIPMENT

44—Flexible-metal-hose Connectors, 16 pp, Cobra Metal Hose.
48—Control Valves, 12 pp, Conoflow Corp.
52—Differential Piston-type Relief Valve, data sheets, Fluid Controls.
56—Square Cylinders, 2 pp, Miller Fluid Power Div, Flick-Reedy Corp.
61—Selection of Cylinders, Tubing, End-seals, 2 pp, Miller Fluid Power Div, Flick-Reedy Corp.

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* Item No.	PRODUCT

1	13	25	37	49	61	73	85	97	109	121	133	145	157	169	181	193	205	217	229	241	253	265	277
2	14	26	38	50	62	74	86	98	110	122	134	146	158	170	182	194	206	218	230	242	254	266	278
3	15	27	39	51	63	75	87	99	111	123	135	147	159	171	183	195	207	219	231	243	255	267	279
4	16	28	40	52	64	76	88	100	112	124	136	148	160	172	184	196	208	220	232	244	256	268	280
5	17	29	41	53	65	77	89	101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281
6	18	30	42	54	66	78	90	102	114	126	138	150	162	174	186	198	210	222	234	246	258	270	282
7	19	31	43	55	67	79	91	103	115	127	139	151	163	175	187	199	211	223	235	247	259	271	283
8	20	32	44	56	68	80	92	104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284
9	21	33	45	57	69	81	93	105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285
10	22	34	46	58	70	82	94	106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286
11	23	35	47	59	71	83	95	107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287
12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288

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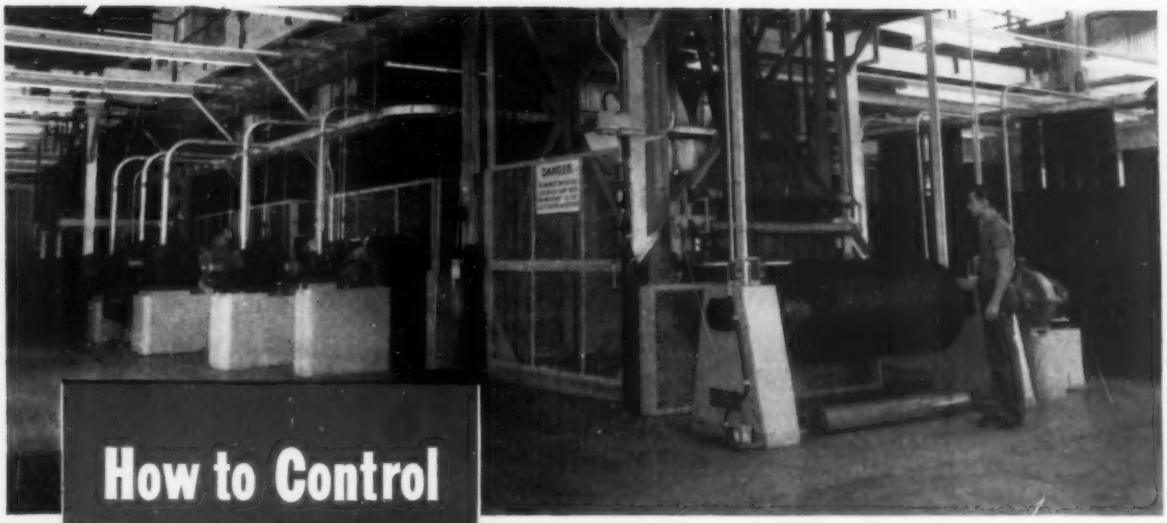
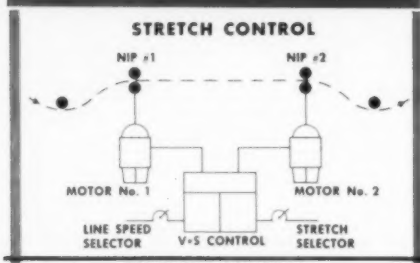
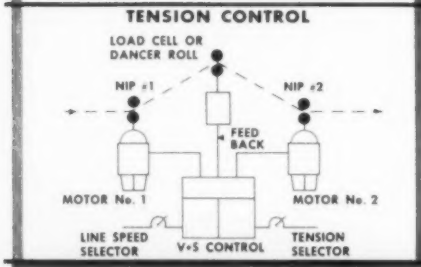
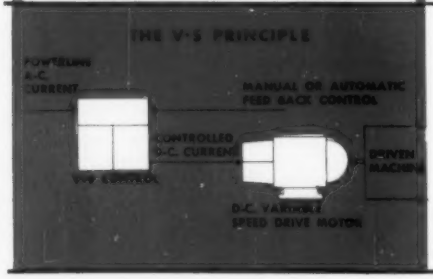


How to Control Tension and Stretch on Web Processes







Reliance Variable Speed Drives will accurately control stretch and tension on web processes such as tire cord dipping, paper making, or plastic film manufacturing.

A Reliance Variable Speed Drive is all electric and operates from a-c. circuits. It consists of motor controls and one or more d-c. drive motors. Speed, horsepower and torque are controlled and changed by regulating the voltage and current supplied to the drive motors. By tying the controls to a system feedback, process regulation becomes completely automatic.

CONTROLLING THE WEB

Reliance V★S Drives control web stretch by maintaining drive motor speed differential. One motor driving a pinch roll or capstan is made to turn faster than the preceding pinch roll motor. By closely regulating this speed differential, elongation of the web is precisely controlled.

Tension control is a different problem. Here a specified amount of pull is exerted on the web, regardless of elongation. A load cell or a dancer roll provides a feedback signal to regulate the drive motors.

SPEED AND TORQUE CONTROL

In controlling tension, drive motor torque is held constant, and speed is varied to accommodate variation in elasticity. Stretch control is maintaining a set drive motor speed differential, and varying torque to accommodate variations in elasticity.

This is one of the many chemical applications of V★S Drives. For further information on Reliance Variable Speed Drives, ⅛ through 200 hp., contact your Reliance Representative, or write for Bulletin No. D-2506. D-1602A

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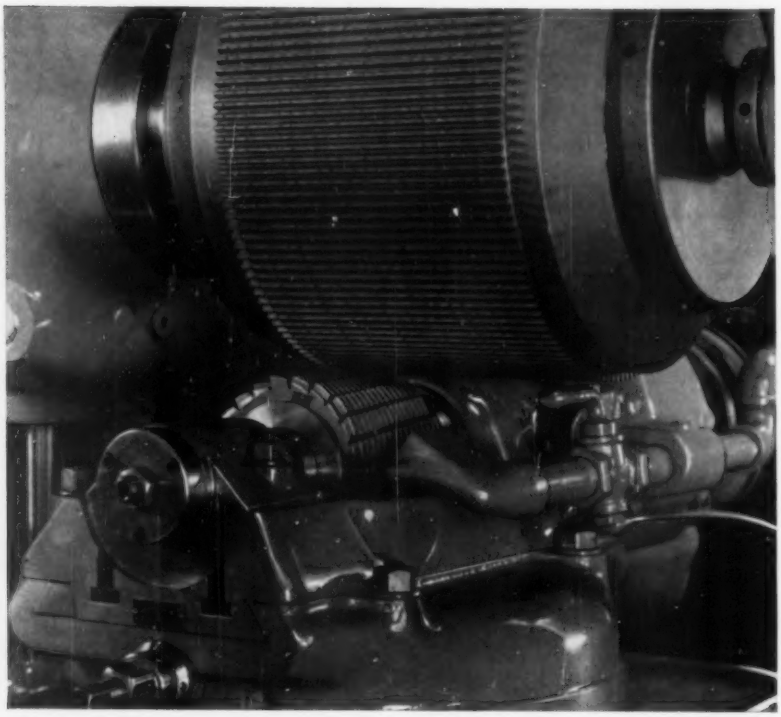
Hobs at speeds of 300 SFM —TIMKEN® bearings shrug off heavy loads



TO take the heavy loads and minimize friction when hobbing steel gears at high speeds—up to 300 SFM—Barber-Colman uses Timken® tapered roller bearings at vital points in its No. 14-15 Hydraulic Hobbing Machine. The high speed hob slide has a hob spindle mounted in Timken bearings. They're also used in the hob drive and for the top bearing on the index worm shaft. Result—gear production is faster, more accurate. Tool life is increased.

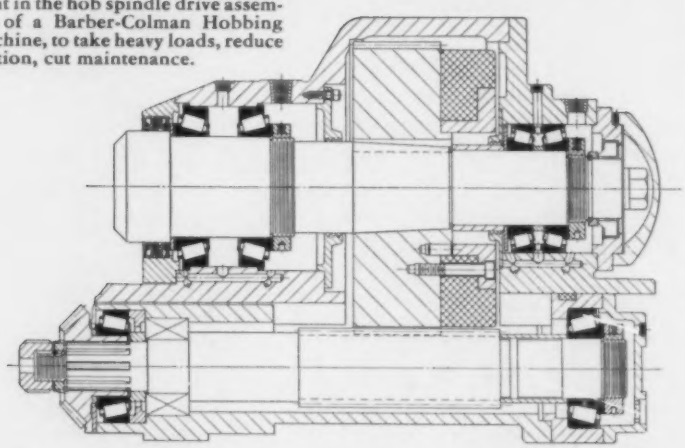
SHRUG OFF HEAVY LOADS. Timken bearing rollers and races are case-carburized to have a hard, wear-resistant surface over a tough, shock-resistant core. They take heavy loads with no trouble at all.

KEEP SPINDLE RIGID. Timken bearings hold the spindle in positive alignment. Their tapered design lets them take *both* radial and thrust loads in any combination. And they have extra load-carrying capacity because of full line contact between rollers and races.

PRACTICALLY ELIMINATE FRICTION. Geometrically designed to roll true, Timken bearings are precision-made to live up to their design. They run longer, smoother, cooler.

And for extra quality control, we even make our own electric furnace fine alloy steel. No other American bearing maker does. To get your No. 1 bearing value, always get bearings carrying the trade-mark "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

TYPICAL Timken bearing arrangement in the hob spindle drive assembly of a Barber-Colman Hobbing Machine, to take heavy loads, reduce friction, cut maintenance.



This symbol on a product means its bearings are the best.

TIMKEN

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